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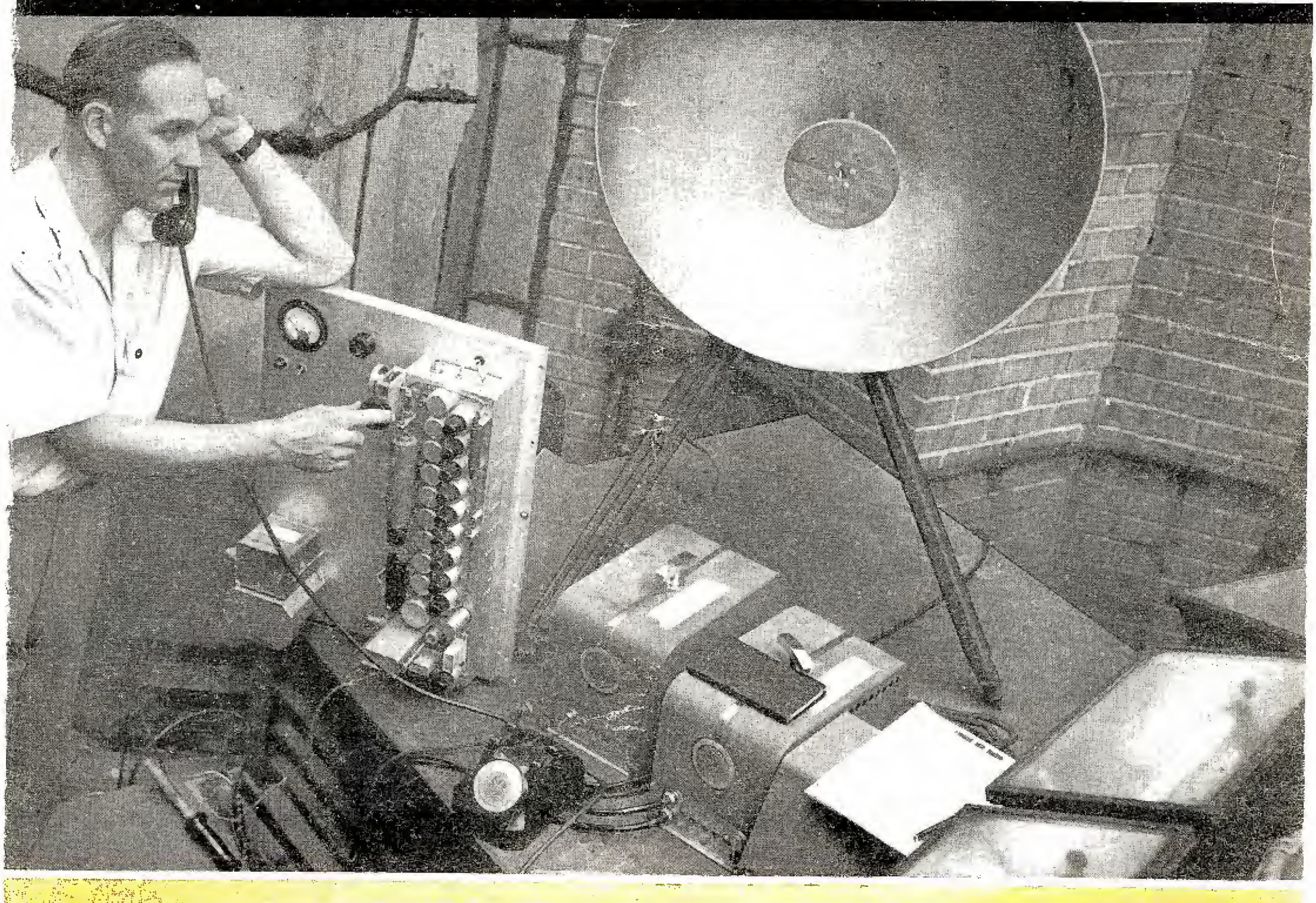

JANUARY

★ TELEVISION ANTENNA DESIGNS ★ 100-KC TO 50-MC FREQUENCY METER

★ TOLEDO-LONDON PARTICIPATING-AUDIENCE BROADCAST SETUP

1947

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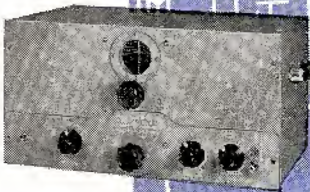

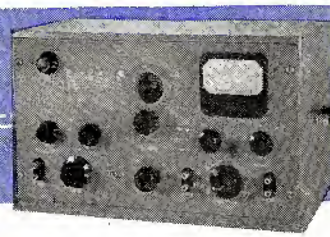

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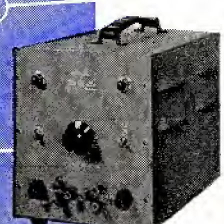

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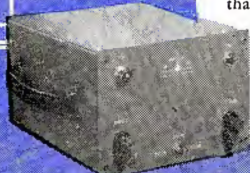

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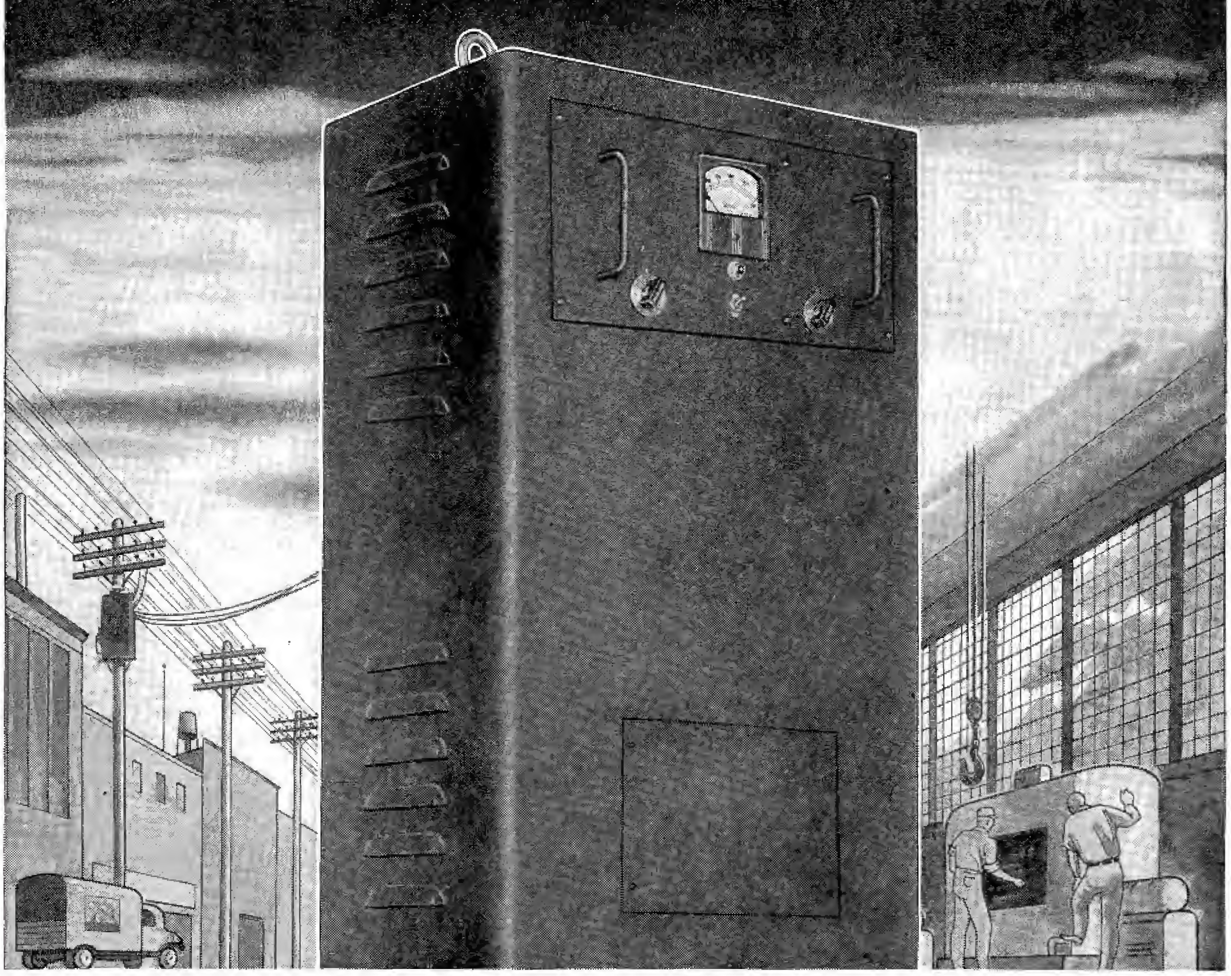

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LEWIS WINNER, Editor

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We See...

The past months have seen unparalleled broadcast-station activity . . . an activity that will undoubtedly race along and along for a-m, f-m and television. A study of the record reveals that 1,062 a-m stations are now on the air and 462 more have received construction permits; a year ago only 64 constuction permits had been issued. In the f-m camp, the increase in operating and soon-to-operate stations has been record-breaking too. On January 1, 1945, only 48 stations had been licensed to operate. Today, the FCC has authorized 136 to go on the air. These include stations with construction permits and conditional grants. On January 1, 1945, only five f-m stations had received construction permits. Today there are 429 with construction permits and 211 with conditional grants. And from a low of 3 to a high of 48 is the record of the construction permits granted to television operators.

The f-m spurt of activity has been fired to a great extent by the FCC interim operating ruling encouraging interim operation by holders of f-m conditional grants or construction permits. In commenting on the issuance of this unusual ruling, the FCC said: "The Commission believes that interim operation is important in the interest of providing f-m program service at the earliest possible date, particularly in view of the construction difficulties at this time and the resultant delay in full completion of many f-m stations. . . . Authorizations will be issued for periods of 90 days or less."

The ruling also emphasized that the FCC . . . "expects full construction of f-m stations to go forward as rapidly as equipment may be obtained and any necessary building construction may be completed in order that the benefits of the f-m broadcast service will be available promptly to as many people as possible."

That return-to-50-mc f-m debate still goes on. Representative Lemke of North Dakota has introduced a new bill directing the FCC to allocate some portion of the 50-mc band to f-m broadcasting. Last year several old-band f-m bills were also introduced, but none passed.

FCC engineers have maintained that the higher frequencies are more satisfactory, and they will continue to exert every effort to keep the present high-frequency allocations. Congressmen seem to think differently and so it goes.

Sound advice to those entering f-m and television was offered by a veteran station operator in Washington recently. Commenting on current building and land problems he said that newcomers and a-m station owners installingf-m should look sharply to the possibilities of utilizing their present locations or a combination setup for f-m and eventually television. Use of a centralized location to minimize investments in building, land and personnel for operation and maintenance would be a wise plan at the present time, stressed this veteran operator.—L. W.

COMMUNICATIONS

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JANUARY, 1947 VOLUME 27 NUMBER 1

COVER ILLUSTRATION

V-h-f/u-h-f setup atop G.E. building in New York City for picking up and relaying of New York City television signals to WRGB. *(Courtesy General Electric)*

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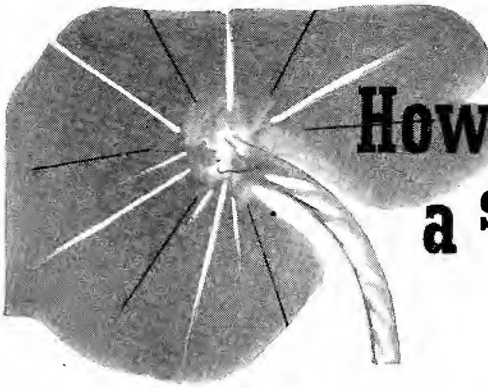
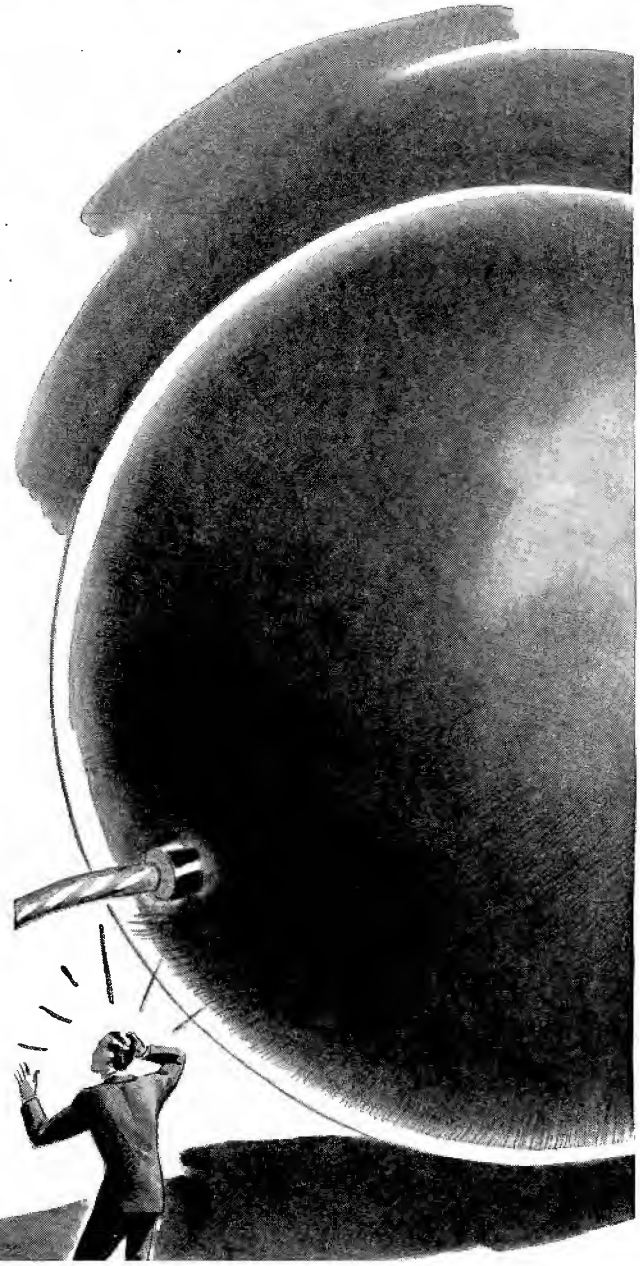


How to Pull the Fuse from a $20,000,000,000 Bomb



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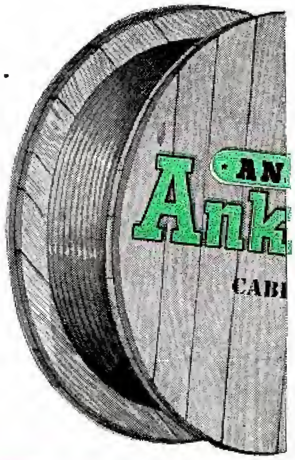

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WTOL-BBC PARTICIPATING AUDIENCE Toledo-London Broadcast

by F. J. SHEEHAN
Chief Engineer, WTOL

Highlights of Equipment and Circuits Used in Recent Transatlantic Broadcast Between Large Participating Audiences.

EARLY LAST SPRING the BBC indicated that they would like to attempt a two-way broadcast between participating audiences in this country and Great Britain, with the program originating from a school auditorium.

The Radio Education Department of Toledo Public Schools became quite interested in this proposal and asked if such a broadcast would be possible. We felt that while such a broadcast would present problems, we could overcome them. Thus we agreed to arrange for the transmission.

We selected the auditorium of Macomber High School as our *studio*

(*Continued on page* 32)

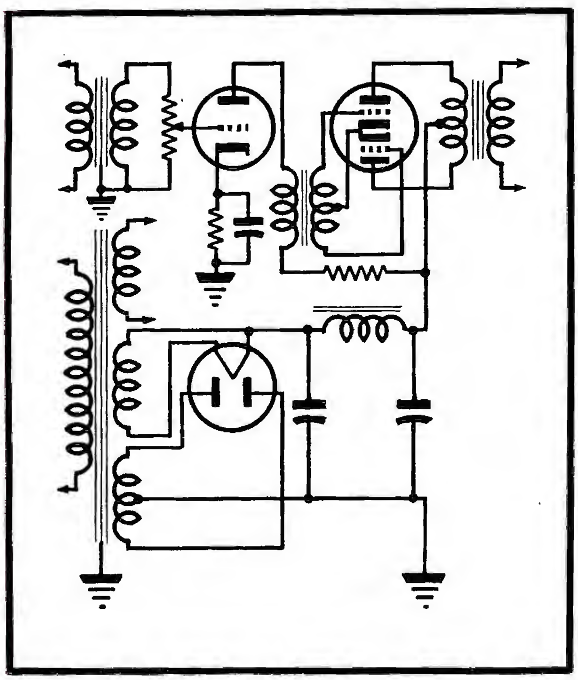


Figure 2
Speaker amplifiers and power supply of WTOL setup.

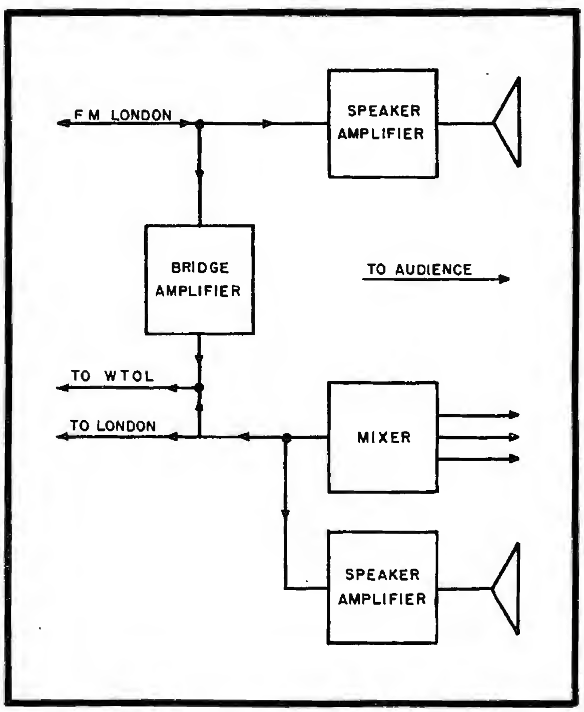


Figure 1
Toledo, Ohio, setup used in WTOL-BBC broadcast.

Application of Transmission Line Measurements To TELEVISION ANTENNA DESIGN

First of a Series on Television Antennas Offers a Theoretical Transmission-Line Termination Analysis and a Study of Actual Measurement Techniques.

by G. EDWARD HAMILTON and RUSSELL K. OLSEN

Senior Engineers, Development Section
Allen B. Du Mont Laboratories

HIGH DEFINITION TELEVISION requires tuned-circuit bandwidths that are very wide, much wider than that necessary for other types of radio communications systems.

For instance in f-m a bandwidth of about 150 kc is necessary for standard broadcast. Amplitude modulation requires only a 30-kc band for high-fidelity transmission. Television service, however, requires a width of at least 4 mc, which represents 8% at 50 mc and 5% at 80 mc. This is equal to a Q of about 5 where $Q = \frac{fr}{\Delta f}$; $\left(fr \pm \frac{\Delta f}{2}\right)$ is 3 db down on the resonance curve.

Since the antenna may be considered a tuned circuit, a broadband frequency characteristic is also required here. The television antenna must therefore:

(*1*) Present a resistive load to the transmission line, in order not to reflect reactance back into the final transmitter output circuit over the entire bandwidth.

(*2*) Employ impedance matching networks so that the antenna effectively sees its self-impedance, care being taken, however, to maintain a low Q at all such sections.

Propagation of u-h-f radiation has been found most satisfactory if horizontally polarized. We have this condition because the vertical heights of interfering structures are greater than the horizontal widths, resulting in greater reflection components of radio energy when vertical polarization is used; i.e., multi-path transmission is more apparent. The antenna is thus further complicated with respect to feed, matching problems and radiated patterns when horizontal polarization is employed.[1]

Transmission Line Characteristics

The requirements for television transmitter antenna systems are so exacting that measurements indicating their performance are necessary. Since transmission lines are used to transfer energy to the antenna, they also may be used to determine the characteristics of the load or antenna.

The voltage and current appearing along a transmission line depends entirely upon its termination; Figure 1 shows the effect of various *single component* terminations.

When the termination is a short circuit, R equals O and there can be no voltage at that point; however, since the energy traveling along the line is not dissipated it is reflected back along the line, causing voltage and current reinforcements or standing waves which can be measured with suitable instruments.

When the termination is an open circuit, R equals ∞ and the maximum voltage will appear at this point. Reflection takes place as before, but where a voltage loop was noted for the short-circuit condition a voltage minimum will now obtain; the minimum and maximum are transposed by 90°.

When capacitive reactance is terminating the line the minimum voltage point moves toward the load with respect to the open-circuit minimum; the effect of capacity is to increase the electrical length of the line. The shift in phase is analogous to an RC phase-shifting device where the angular displacement will vary from 0 to –90°.

Inductive termination effectively decreases the electrical length of the line resulting in shifting the voltage minimum toward the source, when referred to an open circuited condition. The phase shift is analogous to an RL circuit where the angular displacement will vary from 0 to +90°.

[1] FCC standard practice.

Any tuned circuit will have only a resistive value at the resonant frequency. At frequencies above and below resonance, reactance will be present, the magnitude being dependent on the circuit, Q. The lower the Q, the lower will be the reactive component.

Measurements made of the standing-wave voltage ratios along a transmission line are indicative of the mismatch between the line and terminating impedance. To determine the magnitude and phase angle of the line termination (antenna) it will be necessary to review the characteristics of transmission lines with respect to the standing-wave ratio, angular position of voltage maximum and minimum, and the surge impedance of the line. Figure 2 shows a section of transmission line from which general equations of propagation will be shown.

In these equations, the following symbols are used:

E	=	voltage expressed as rms complex values at steady state at point M
I	=	current expressed as rms complex values at point M
E_S and I_S	=	respective voltage and current values at sending end x units from point M
E_s and I_s	=	respective voltage and current values at terminating or *receiving* end, d units from M
Z_0	=	characteristic impedance of line
d and x	=	expressions in terms of linear measurement
A and B	=	constants depending on the length of the line and its termination
z	=	per unit length series impedance of the transmission line

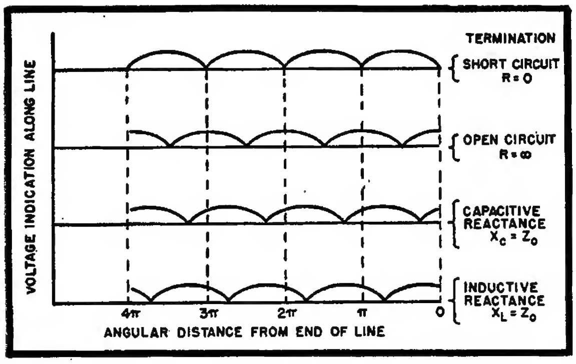


Figure 1
Effect of single component terminations.

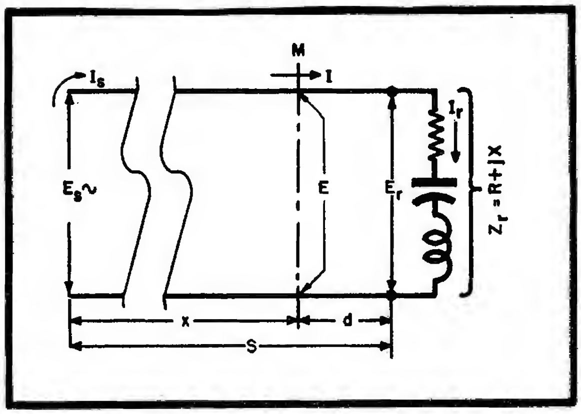


Figure 2
General transmission line with Z_r termination.

y = per unit length shunt admittance of the transmission line
Z = impedance at any point (M) along the transmission line
γ = propagation constant
α = attenuation constant of the transmission line
$\beta = \frac{2\pi}{\lambda}$ = phase constant of the transmission line; determines the velocity of phase propagation
r = resistance of line per unit length
g = shunt conductance per unit length
l = series inductance of line per unit length
c = shunt capacitance of line per unit length.

The general solution of transmission lines has been shown to be:

$$E = A\epsilon^{-\sqrt{zy}x} + B\epsilon^{+\sqrt{zy}x} \qquad (1)$$

$$I = \frac{A}{Z_0}\epsilon^{-\sqrt{zy}x} - \frac{B}{Z_0}\epsilon^{+\sqrt{zy}x} \qquad (2)$$

$$Z = \frac{E}{I} = \frac{A\epsilon^{-\sqrt{zy}x} + B\epsilon^{+\sqrt{zy}x}}{\frac{A}{Z_0}\epsilon^{-\sqrt{zy}x} - \frac{B}{Z_0}\epsilon^{+\sqrt{zy}x}} \qquad (3)$$

$$Z = \frac{Z_0\left[A\epsilon^{-\sqrt{zy}x} + B\epsilon^{+\sqrt{zy}x}\right]}{A\epsilon^{-\sqrt{zy}x} - B\epsilon^{-\sqrt{zy}x}} \qquad (4)$$

The propagation constant of any transmission line is defined as:

$$\gamma = \sqrt{zy} = \sqrt{(r + j\omega l)(g + j\omega c)} \qquad (5)$$

Since γ contains real and imaginary quantities, it may be expressed as

$$\gamma = \alpha + j\beta \qquad (6)$$

Therefore, equation (*4*) may be written in the more common form of

$$Z = \frac{Z_0\left[A\epsilon^{-\gamma x} + B\epsilon^{+\gamma x}\right]}{A\epsilon^{-\gamma x} - B\epsilon^{+\gamma x}} \qquad (7)$$

Where short physical lengths are involved and high frequencies are considered, the losses in transmission lines may be neglected. Equation (*6*) may therefore be reduced to

$$\gamma = j\beta \text{ (since } r = 0 \text{ and } g = 0\text{)} \qquad (8)$$

Equation (*7*) may be reduced to the following expression, for the case of a lossless line,

$$Z = \frac{Z_0\left[A\epsilon^{-j\beta x} + B\epsilon^{+j\beta x}\right]}{A\epsilon^{-j\beta x} + B\epsilon^{+j\beta x}} \qquad (9)$$

The constants A and B may be solved by setting equations (*1*) and (*2*) to the limiting case, where $x = s$.

$$E_r = A\epsilon^{-j\beta s} + B\epsilon^{+j\beta s} \qquad (1a)$$

$$I_r = \frac{A}{Z_0}\epsilon^{-j\beta s} - \frac{B}{Z_0}\epsilon^{+j\beta s} \qquad (2a)$$

Solving the above two equations simultaneously, we have

$$E_r - B\epsilon^{+j\beta s} = I_r Z_0 + B\epsilon^{+j\beta s} \qquad (10)$$

$$B = \frac{E_r - I_r Z_0}{2\epsilon^{+j\beta s}} = \frac{I_r}{2}(Z_r - Z_0)\epsilon^{-j\beta s} \qquad (11)$$

Substituting the value of B in equation (*2a*), we have

$$I_r = \frac{A}{Z_0}\epsilon^{-j\beta s} - \frac{I_r}{2Z_0}(Z_r - Z_0)\epsilon^{-j\beta s}\epsilon^{+j\beta s}$$
$$= \frac{A}{Z_0}\epsilon^{-j\beta s} - \frac{I_r}{2Z_0}(Z_r - Z_0) \qquad (12)$$

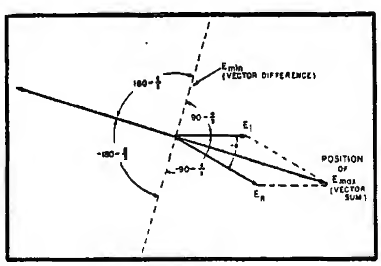


Figure 3
Revolving vectors, E_I and E_R, and the position of minimum and maximum occurrence.

$$A = \left[I_r + \frac{I_r}{2Z_0}(Z_r - Z_0)\right]Z_0\epsilon^{+j\beta s} \qquad (13)$$

$$A = \frac{I_r}{2}(Z_0 + Z_r)\epsilon^{+j\beta s} \qquad (14)$$

Substituting equations (*11* and *14*) in the general line equations, we obtain

$$I = \frac{A}{Z_0}\epsilon^{-j\beta x} - \frac{B}{Z_0}\epsilon^{+j\beta x} \qquad (15)$$

$$E = \frac{I_r}{2}(Z_0 + Z_r)\epsilon^{+j\beta(s-x)} + \frac{I_r}{2}(Z_r - Z_0)\epsilon^{-j\beta(x-s)} \qquad (16)$$

But Figure 2 shows that $s - x = d$, which when substituted in (*16*), gives

$$E = \frac{1}{2}\left\{\left[I_r Z_0 + E_r\right]\epsilon^{+j\beta d} + \left[E_r - I_r Z_0\right]\epsilon^{-j\beta d}\right\}$$

Since $\epsilon^{\pm jx} = \text{Cos } x \pm j \text{ Sin } x$

$$E = \frac{1}{2}\left\{\left[I_r Z_0 + E_r\right]\text{Cos }\beta d + j\left[I_r Z_0 + E_r\right]\text{ Sin }\beta d + \left[E_r - I_r Z_0\right]\text{Cos }\beta d - j\left[E_r - I_r Z_0 \text{Sin }\beta d\right]\right\}$$

Upon expansion and collection of terms,

$$E = E_r \text{Cos }\beta d + jI_r Z_0 \text{Sin }\beta d$$

$$I = \frac{I_r}{2Z_0}(Z_0 + Z_r)\epsilon^{+j\beta(s-x)} - \frac{I_r}{2Z_0}(Z_r - Z_0)\epsilon^{-j\beta(s-x)}$$
$$= \frac{I_r}{2Z_0}(Z_0 + Z_r)\epsilon^{+j\beta d} - \frac{I_r}{2Z_0}(Z_r - Z_0)\epsilon^{-j\beta d}$$
$$= \frac{I_r}{2Z_0}\left\{\left[Z_0 + Z_r\right]\text{Cos }\beta d + j\left[Z_0 + Z_r\right]\text{Sin }\beta d - \left[Z_r - Z_0\right]\text{Cos }\beta d + j\left[Z_r - Z_0\right]\text{Sin }\beta d\right\} \qquad (17)$$

Upon expansion and collection of terms,

$$I = I_r \text{Cos }\beta d + j\frac{E_r}{Z_0}\text{Sin }\beta d \qquad (18)$$

$$Z = \frac{E}{I} = \frac{E_r \text{Cos}\beta d + jI_r Z_0 \text{Sin}\beta d}{I_r \text{Cos }\beta d + j\frac{E_r}{Z_0}\text{Sin}\beta d}$$

$$Z = Z_0\frac{I_r Z_r + jI_r Z_0 \text{Tan }\beta d}{I_r Z_0 + jE_r \text{Tan }\beta d} \qquad (19)$$

$$Z = \frac{Z_0(Z_r + jZ_0 \text{Tan }\beta d)}{Z_0 + jZ_r \text{Tan}\beta d} \qquad (20)$$

Equation (*20*) is the general expression for impedance at any point (M)
(*Continued on page* 35)

A FREQUENCY METER For The 100-KC To 50-MC Range

Instrument Features Internal Calibrating Oscillator Using a 100-kc Crystal, Calibrated Oscillator Tuning Range from 1 to 2 mc in Five 200-kc Ranges, and Flexible Coupling for External Signals.

by A. J. ZINK, JR.

Engineer, Browning Laboratories, Inc.

ONE OF THE MOST USEFUL PIECES of equipment for laboratory or general maintenance work in the communications field is the heterodyne frequency meter.

In the design of a satisfactory frequency meter, a compromise must be made among the factors of accuracy, frequency coverage and operating convenience. Operating convenience is of real importance, since the problem of locating the approximate frequency of the signal being measured is usually great.

Tuning Range

Is well known that for continuous frequency coverage the tunable oscillator must span a 2 to 1 frequency range. If the resulting harmonic frequency coverage of such an oscillator is plotted, as in Figure 1, it becomes apparent that the increase in tuning range for each additional harmonic is 2 mc. In Figure 1, for example, complete coverage can be obtained up to 30 mc by utilizing all harmonics up to the fifteenth. If we utilize the sixteenth harmonic, we gain 2 mc more tuning range or about 7%. Had we been using the twenty-fifth harmonic at 50 mc, the additional tuning range gained by utilizing the twenty-sixth harmonic again represents 2 mc but only 4% additional frequency coverage. Rapidly decreasing efficiency places an arbitrary limit of 50 mc on the model* we designed even though higher frequency signals can be detected.

Thus far, we have been concerned only with the use of the heterodyne frequency meter at its harmonic frequencies. Now let us consider the case of unknown frequencies below the fundamental.

It is often desired to check the calibration of low-frequency signal generators and the local oscillators of low-frequency receivers. In the first case, both harmonic content and the available output voltage is low. The receiver local oscillator can be assumed to have considerable harmonic content and output voltage, but any coupling to it should be loose. Remembering that the operation of the frequency meter at frequencies below the fundamental requires that a harmonic of the unknown beat with the fundamental of the frequency meter, it is apparent that low-frequency coverage should not be based upon the premise that low-frequency signals have high harmonic content.

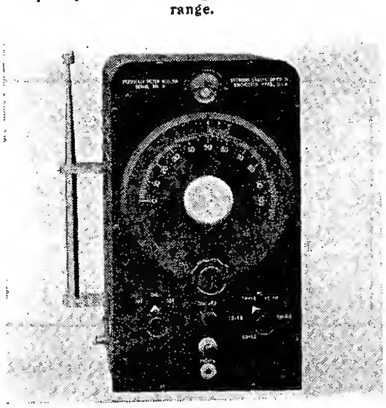
In summary, by choosing an oscillator frequency range of 1 to 2 mc, we shall arbitrarily say that the useful measurement range is from 100 kc to 50 mc. This choice is made assuming that we utilize the tenth subharmonic through the twenty-fifth harmonic of the calibrated oscillator. This choice obviates the need of high-power and distortion levels at low frequencies, and makes best use of the ever-narrowing tuning range at the high frequencies.

Frequency Bands

The choice of frequency bands is largely concerned with dividing the chosen frequency range into easily grouped submultiples of 1 mc. Here the factor of required accuracy is of prime importance. Assuming that a dial mechanism is available which is readable to one part in 1,000, a division of 1 mc into ten ranges would yield an approximate resolution of .01%. If the 1-mc range were to be divided into five bands, the resolution would be .02%. It is quite apparent that a major restriction on accuracy is the difficulty in producing a mechanical tuning system with high resolution.

The availability of five position switches, plus the fact that the switch dimensions are such that coils and trimmers may be adequately grouped about the contacts, makes their use desirable. For these reasons, the model we developed has five bands, each 200 kc in width.

Frequency meter covering the 100-kc to 50-mc range.



Calibrating Oscillator

A built-in calibrating oscillator utilizing a low-drift quartz crystal is a necessity if long-time accuracy is to be obtained. It is desirable to have the crystal oscillator yield an adequate number of check points on each band. It is also convenient if the crystal operates at a frequency which can be periodically checked against a primary frequency standard. By selecting a crystal which operates at 100 kc, both of these requirements can be fulfilled. Several strong check points are available on each band; also the fiftieth harmonic of the crystal may be checked against the 5-mc signal of WWV utilizing a standard frequency calibrator,** or a communications receiver. Of equal importance to the above two factors, is the fact that the long-time sta-

*S-6.

**Browning RH-10.

bility characteristics of 100-kc crystals are rather well known. In general, crystal aging averages less than ±.01% over a period of several months.

Power Supply

Most general-purpose laboratory instruments are used in setups with other equipment and are usually tied to a common ground point. To avoid differences in chassis potentials, it is important that complete isolation from the line be obtained through use of a transformer. Bypassing both sides of the a-c line to chassis should also be avoided, since the capacity divider thus created elevates the chassis well above ground potential. Not only is a transformer-type power supply used in this frequency meter but the output voltage has excellent regulation. Additional gas-tube regulation is employed for the crystal and calibrated oscillator stages.

Coupling Means

Readily adjustable coupling to the instrument from radiated signals is obtained through a five-section 24" telescoping antenna mounted on the instrument case. Direct connections may also be made to this antenna. A ground terminal is provided which is entirely isolated from the a-c line.

An input signal of 1-millivolt amplitude is required for routine measurement.

The tunable oscillator is carefully calibrated at 10-kc intervals by use of external laboratory equipment. If the 100-kc crystal oscillator is then allowed to beat against the tunable oscillator, an audio note is available at the headphone jack. Three strong zero-beat points are obtained per band. These points are located at even 100-kc intervals, i.e., 1.0, 1.1, 1.2 mc on the first band; 1.2, 1.3, 1.4 mc on the second band, etc. A three-point check is thus obtainable, which permits the original calibration curve to be exactly reestablished. The calibrator may be turned off and an unknown signal compared with the calibrated tunable oscillator. The same mixer and audio-frequency amplifier is employed for frequency measurement as for calibration.

Tunable Oscillator

The most essential requirement of the tunable oscillator is that it remain stable despite sudden line-voltage fluctuations, or ambient-temperature changes. Long-time stability is much less important, since the crystal oscillator may always be relied upon for standardization. The well-known electron coupled oscillator with separate tuned circuits for each band was selected for this instrument. All trimmer capacitors employ air dielectric and coil forms are grooved for highest stability. All tuned circuits are shorted to ground except for the particular range in use. Anode voltages are regulated.

The mixer circuit uses one-half of a dual triode, the other half being the audio stage. All r-f signals are fed to a point of low impedance for audio frequency before being fed to the mixer

(*Continued on page* 29)

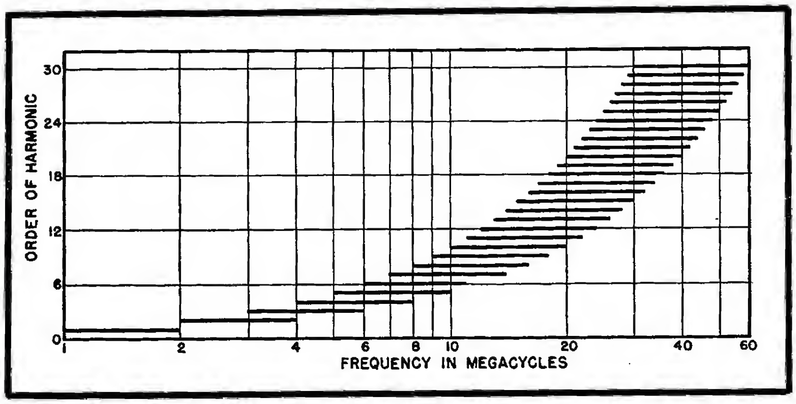


Figure 1
Harmonic frequency coverage of a 1 to 2-mc oscillator.

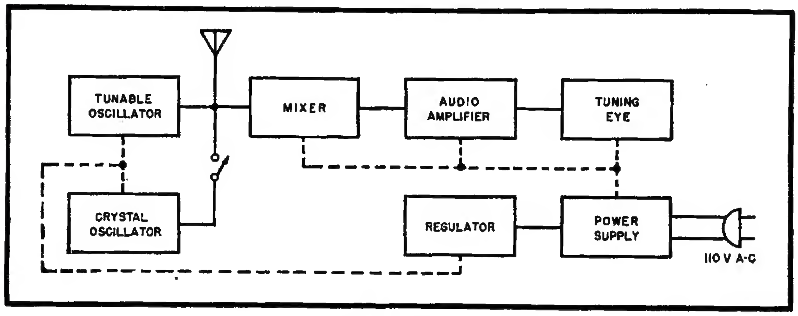
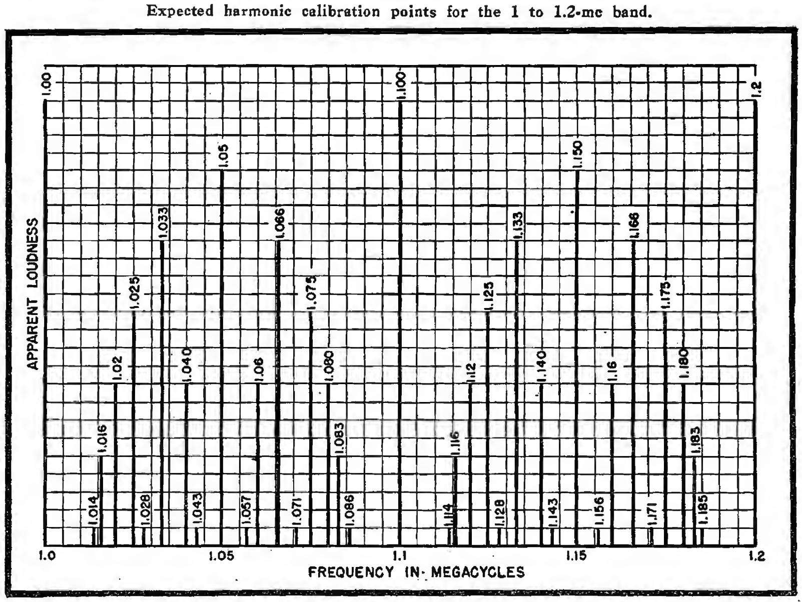
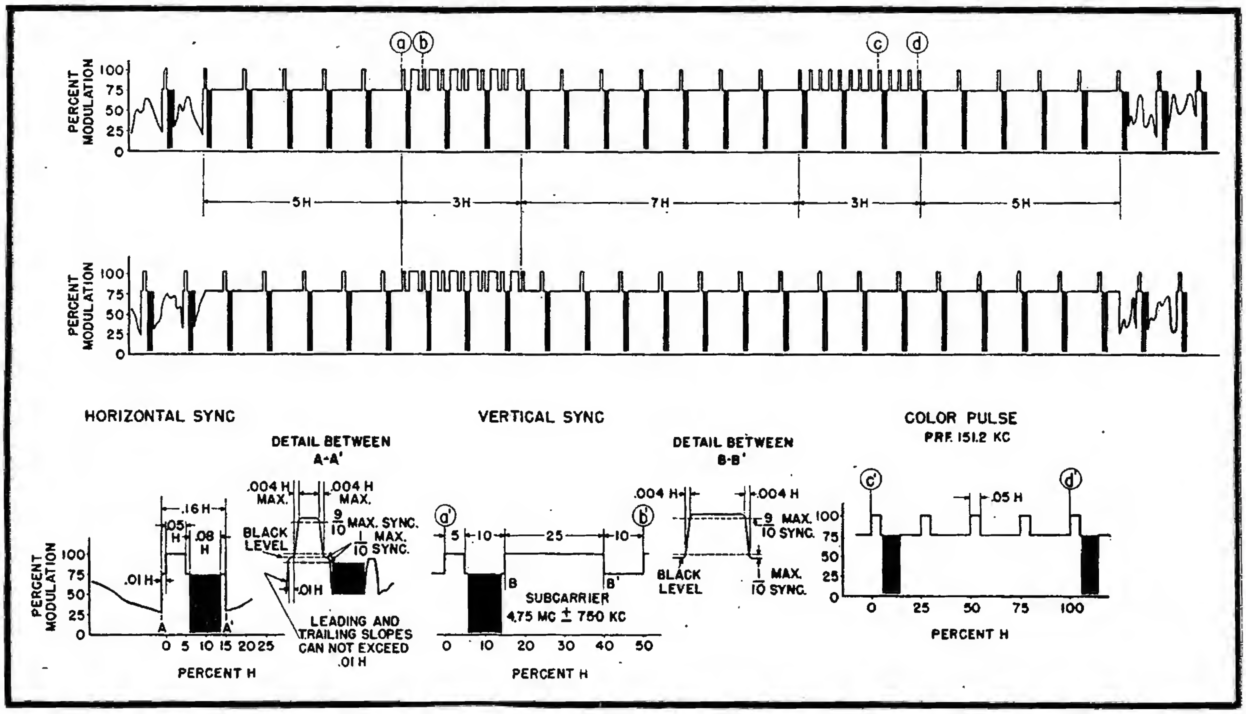


Figure 2
Block diagram of frequency meter.

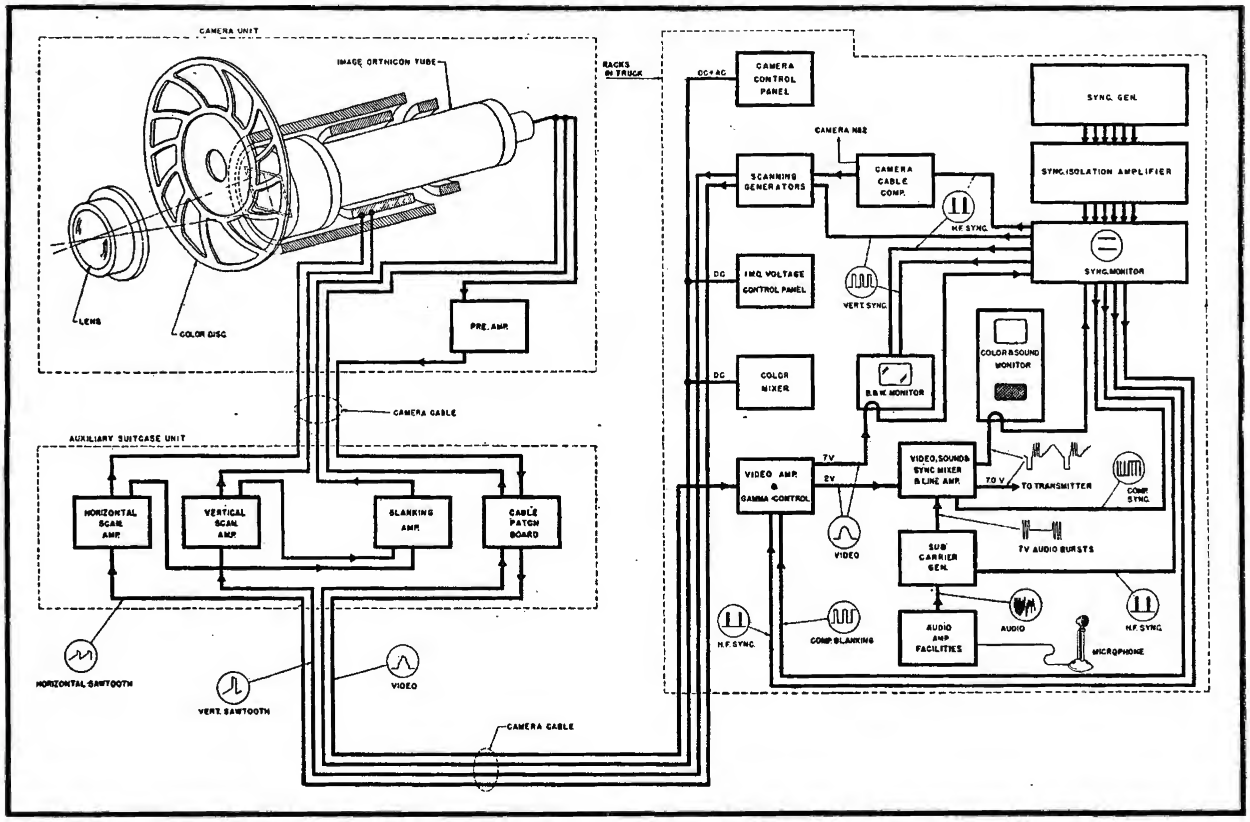
Figure 3
Expected harmonic calibration points for the 1 to 1.2-mc band.



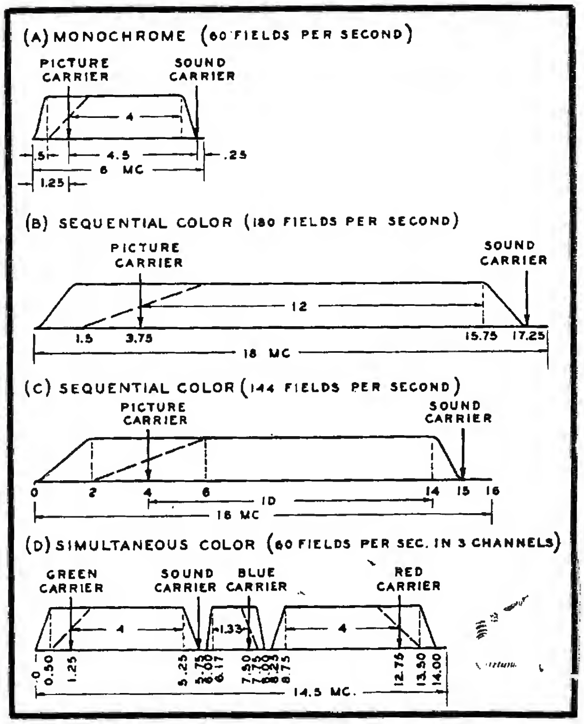
Color TELEVISION



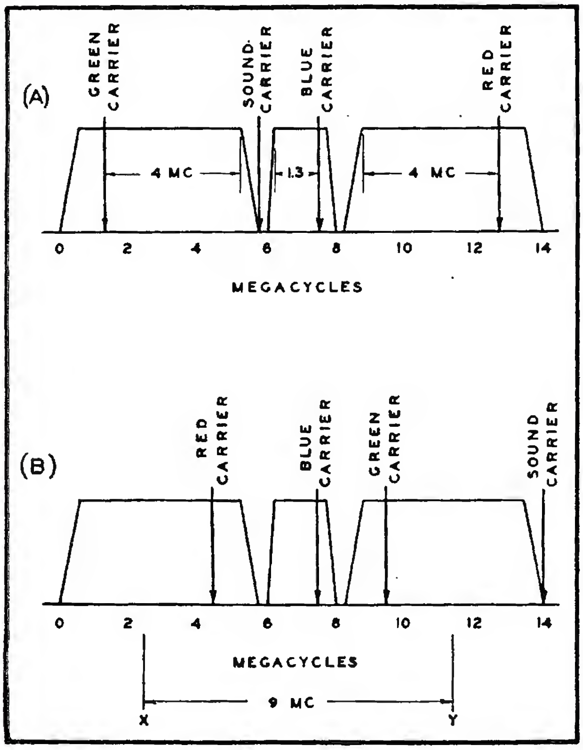
Above . . . CBS proposed standards for 525-line u-h-f color **television, sound and** synchronizing wave forms: H = 26.5 microseconds; F_H = 37.8 kc; color field frequency = 144 per second; frame frequency = 72 per second; color frame frequency = 48 per second; and color picture frequency = 24 per second. Below, image orthicon remote color-television pickup equipment described by CBS at FCC hearings.



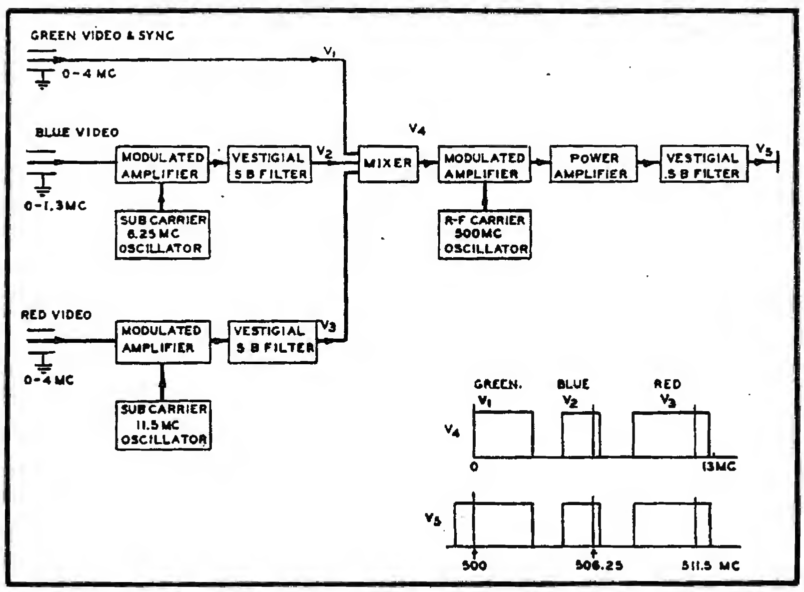
Sequential and Simultaneous Color-Television System Exhibits Presented at FCC Color Television Standards Hearings in Washington, D. C.



Above . . . bandwidth requirements of television systems as analyzed by R. D. Kell on behalf of RCA and NBC at the FCC hearings. At *A* are the present FCC standards indicating the manner in which 6-mc channels are used for the current monochrome television system. Dashed curve has been added to this drawing to indicate manner in which an ideal receiver attenuates the vestigial lower sideband; the ratio of the width of the used vestigial sideband to the full sideband is .75/4. *B* illustrates the bandwidth occupied by a 180-field-per-second sequential television system designed to provide the same resolution as that obtainable in monochrome system. Field frequency of 180 is necessary to reduce flicker to an acceptable level. Bandwidth from picture carrier to the decline of the upper sideband is 12-mc or three times that of monochrome system, because of tripled field frequency of the sequential color system. *C* illustrates sequential color bandwidth requirements as described by CBS. It must be remembered, however, that this cannot be compared directly with other diagrams of this figure because of its design for a field frequency of 144 fields per second. In *D* appears one of several possible allocations for transmitting by the simultaneous color system. The bandwidths and spacing of the green channel and sound channel have been made the same as the present monochrome allocation. The red channel has been made like the green except that the lower sideband is used. The blue channel is 1/3 as wide as the green and the bandwidth for its attenuations have been made proportional. A channel of 14 to 15-mc is indicated, representing a saving of approximately 3 mc over the sequential system with 180 fields.

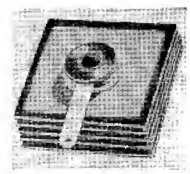


Above, two alternate radio-channel arrangements for transmission of simultaneous color-television signals. A ratio of vestigial sideband to transmitted sideband width of .75/4 is used to provide good transient response and is in accordance with current monochrome standards. System shown in *B* permits the i-f circuits to include a restricted spectrum, such as *X-Y*. In this type receiver the sound would be received by a very narrow band, i-f amplifier having a response outside of the *X-Y* region.



Right, a subcarrier system in which the green signal is applied in video form to the main modulated amplifier and the blue and red signals are placed on subcarriers before application to the main modulated amplifier. The spectrums at various points, V_1 to V_5, in the transmitter are indicated in this diagram.

Voltage Multiplier Circuits WITH SELENIUM RECTIFIERS



by E. W. CHADWICK

Rectifier Engineer
Federal Telephone and Radio Corp.

Discussion of Doubler, Tripler and Quadrupler Circuits Using Dry-Disc Rectifiers.

A COMPLETELY NEW APPROACH to the design of 200 to 500 v d-c power supplies is now possible as a result of the development of the miniature selenium rectifier. These rectifiers, because of their high-current carrying capacity, can be successfully utilized in voltage-multiplier circuits and thereby deliver 200 to 500 v d-c from a 117 v a-c source without the use of a power transformer.

The use of rectifiers in voltage-multiplier circuits is in itself not novel and has been used before. However, when applied to vacuum-tube rectifiers, this design is highly impractical. There are two reasons for this. In the first place, with the tube filaments connected in series in this type of chain circuit, there exists dangerously high-potential differences between heaters and cathodes of the rectifier tubes at the high-voltage end of the system. This difficulty might, of course, be obviated by the use of heater supply transformers but this destroys the simplicity of the system.[1] However, since selenium rectifiers do not use filaments, this problem does not exist when they are used. Low-current rating, resulting in poor-voltage regulation, is the second reason for the inadaptability of vacuum tubes to this type of a circuit.

This latter point is graphically illustrated on Figure 1. Here the regulation curves of a selenium rectifier are compared with those of a 25Z6 tube. From the theory of power supplies[2] it is known that the degrees of regulation will depend to a great extent on the size of the capacitor immediately following the rectifier (shunt capacitor input-filter circuit). The size of this capacitor, in turn, is limited by the current-carrier capacity of the rectifier. Since a selenium rectifier will safely pass more current, both transient and steady state, a larger capacitor can be used and improved voltage regulation obtained. In the design of receivers this means increased sensitivity since there is a lower noise modulation, due to the improved voltage regulation, in each tube of the set.

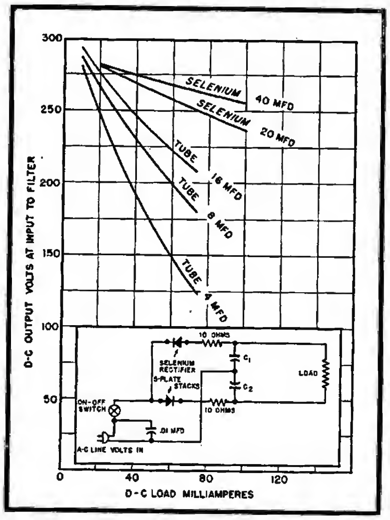


Figure 1
Comparison of voltage regulation curves obtained with a 25Z6-rectifier tube and a miniature selenium rectifier. Total effective plate supply impedance is 15 ohms.

The elimination of the power transformer in television sets, besides cutting down on weight, size, and cost, also provides another important feature. Television engineers have long been confronted with the problem of stray magnetic field interference on the cathode-ray tube, caused, in the main, by the transformer. Thus, by the use of voltage-multiplier circuits, a major source of interference can be eliminated.

Figures 2 and 3 show a typical voltage doubler and tripler circuit, respectively. All of these circuits indicate the use of a 200-ma selenium rectifier. However, if a 200-ma power supply is not necessary, lower-rated selenium rectifiers can be used. Selenium discs can also be used in quadrupler circuits with dual-capacitor filtering.

[1]Mallory Technical Manual, p. 59.
[2]F. E. Terman, *Radio Engineering*, pp. 491-498.

Figure 2
Voltage-doubler circuit using two 200-ma selenium rectifiers. *R* is normally 5 ohms but if necessary this can be increased to keep selenium rectifier temperature to 75°C or less.

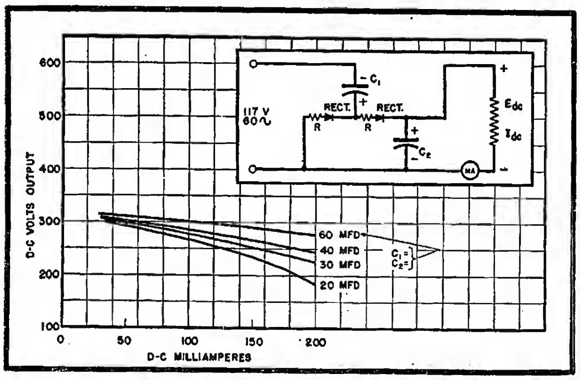
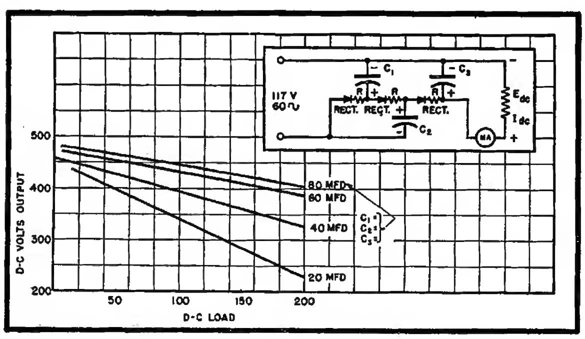


Figure 3
Voltage-tripler circuit using three 200-ma selenium rectifiers. *R* here is also normally 5 ohms but can be increased to keep selenium rectifier temperature to 75°C or less.



COMMUNICATIONS
LEWIS WINNER, Editor
* * JANUARY, 1947 * *

WTOL-BBC PARTICIPATING AUDIENCE
Toledo-London Broadcast

by F. J. SHEEHAN
Chief Engineer, WTOL

Highlights of Equipment and Circuits Used in Recent Transatlantic Broadcast Between Large Participating Audiences.

Early last spring the BBC indicated that they would like to attempt a two-way broadcast between participating audiences in this country and Great Britain, with the program originating from a school auditorium.

The Radio Education Department of Toledo Public Schools became quite interested in this proposal and asked if such a broadcast would be possible. We felt that while such a broadcast would present problems, we could overcome them. Thus we agreed to arrange for the transmission.

We selected the auditorium of Macomber High School as our *studio*

(*Continued on page* 32)

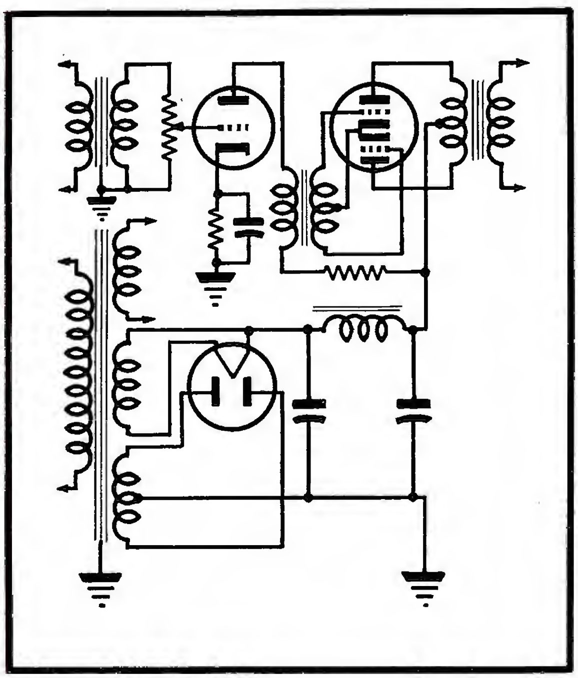


Figure 2
Speaker amplifiers and power supply of WTOL setup.

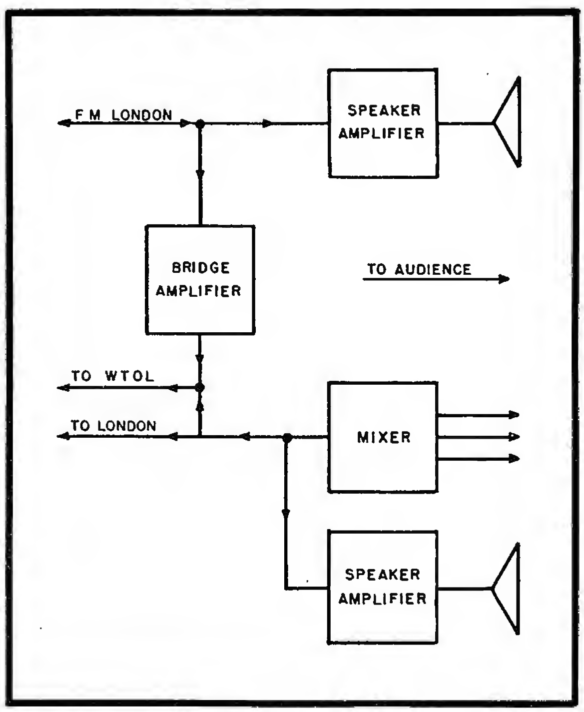


Figure 1
Toledo, Ohio, setup used in WTOL-BBC broadcast.

Application of Transmission Line Measurements To TELEVISION ANTENNA DESIGN

First of a Series on Television Antennas Offers a Theoretical Transmission-Line Termination Analysis and a Study of Actual Measurement Techniques.

by G. EDWARD HAMILTON and RUSSELL K. OLSEN

Senior Engineers, Development Section
Allen B. Du Mont Laboratories

HIGH DEFINITION TELEVISION requires tuned-circuit bandwidths that are very wide, much wider than that necessary for other types of radio communications systems.

For instance in f-m a bandwidth of about 150 kc is necessary for standard broadcast. Amplitude modulation requires only a 30-kc band for high-fidelity transmission. Television service, however, requires a width of at least 4 mc, which represents 8% at 50 mc and 5% at 80 mc. This is equal to a Q of about 5 where $Q = \dfrac{fr}{\Delta f}$; $\left(fr \pm \dfrac{\Delta f}{2}\right)$ is 3 db down on the resonance curve.

Since the antenna may be considered a tuned circuit, a broadband frequency characteristic is also required here. The television antenna must therefore:

(*1*) Present a resistive load to the transmission line, in order not to reflect reactance back into the final transmitter output circuit over the entire bandwidth.

(*2*) Employ impedance matching networks so that the antenna effectively sees its self-impedance, care being taken, however, to maintain a low Q at all such sections.

Propagation of u-h-f radiation has been found most satisfactory if horizontally polarized. We have this condition because the vertical heights of interfering structures are greater than the horizontal widths, resulting in greater reflection components of radio energy when vertical polarization is used; i.e., multi-path transmission is more apparent. The antenna is thus further complicated with respect to feed, matching problems and radiated patterns when horizontal polarization is employed.[1]

Transmission Line Characteristics

The requirements for television transmitter antenna systems are so exacting that measurements indicating their performance are necessary. Since transmission lines are used to transfer energy to the antenna, they also may be used to determine the characteristics of the load or antenna.

The voltage and current appearing along a transmission line depends entirely upon its termination; Figure 1 shows the effect of various *single component* terminations.

When the termination is a short circuit, R equals O and there can be no voltage at that point; however, since the energy traveling along the line is not dissipated it is reflected back along the line, causing voltage and current reinforcements or standing waves which can be measured with suitable instruments.

When the termination is an open circuit, R equals ∞ and the maximum voltage will appear at this point. Reflection takes place as before, but where a voltage loop was noted for the short-circuit condition a voltage minimum will now obtain; the minimum and maximum are transposed by 90°.

When capacitive reactance is terminating the line the minimum voltage point moves toward the load with respect to the open-circuit minimum; the effect of capacity is to increase the electrical length of the line. The shift in phase is analogous to an RC phase-shifting device where the angular displacement will vary from 0 to −90°.

Inductive termination effectively decreases the electrical length of the line resulting in shifting the voltage minimum toward the source, when referred to an open circuited condition. The phase shift is analogous to an RL circuit where the angular displacement will vary from 0 to +90°.

[1] FCC standard practice.

Any tuned circuit will have only a resistive value at the resonant frequency. At frequencies above and below resonance, reactance will be present, the magnitude being dependent on the circuit, Q. The lower the Q, the lower will be the reactive component.

Measurements made of the standing-wave voltage ratios along a transmission line are indicative of the mismatch between the line and terminating impedance. To determine the magnitude and phase angle of the line termination (antenna) it will be necessary to review the characteristics of transmission lines with respect to the standing-wave ratio, angular position of voltage maximum and minimum, and the surge impedance of the line. Figure 2 shows a section of transmission line from which general equations of propagation will be shown.

In these equations, the following symbols are used:

E	= voltage expressed as rms complex values at steady state at point M
I	= current expressed as rms complex values at point M
E_S and I_S	= respective voltage and current values at sending end x units from point M
E_r and I_r	= respective voltage and current values at terminating or *receiving* end, d units from M
Z_o	= characteristic impedance of line
d and x	= expressions in terms of linear measurement
A and B	= constants depending on the length of the line and its termination
z	= per unit length series impedance of the transmission line

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Price, complete with test leads $38.95
Carrying case 5.55

Volts D.C. (At 20,000 ohms per volt)	Volts A.C. (At 1,000 ohms per volt)	Output
2.5	2.5	2.5 V.
10	10	10 V.
50	50	50 V.
250	250	250 V.
1000	1000	1000 V.
5000	5000	5000 V.

Milli-amperes D.C.	Micro-amperes	Ohms	
10	100	0-1000	(12 ohms center)
100		0-100,000	(1200 ohms center)
500		0-10 Megohms	(120,000 ohms center)

(5 Decibel ranges: —10 to +52 DB)

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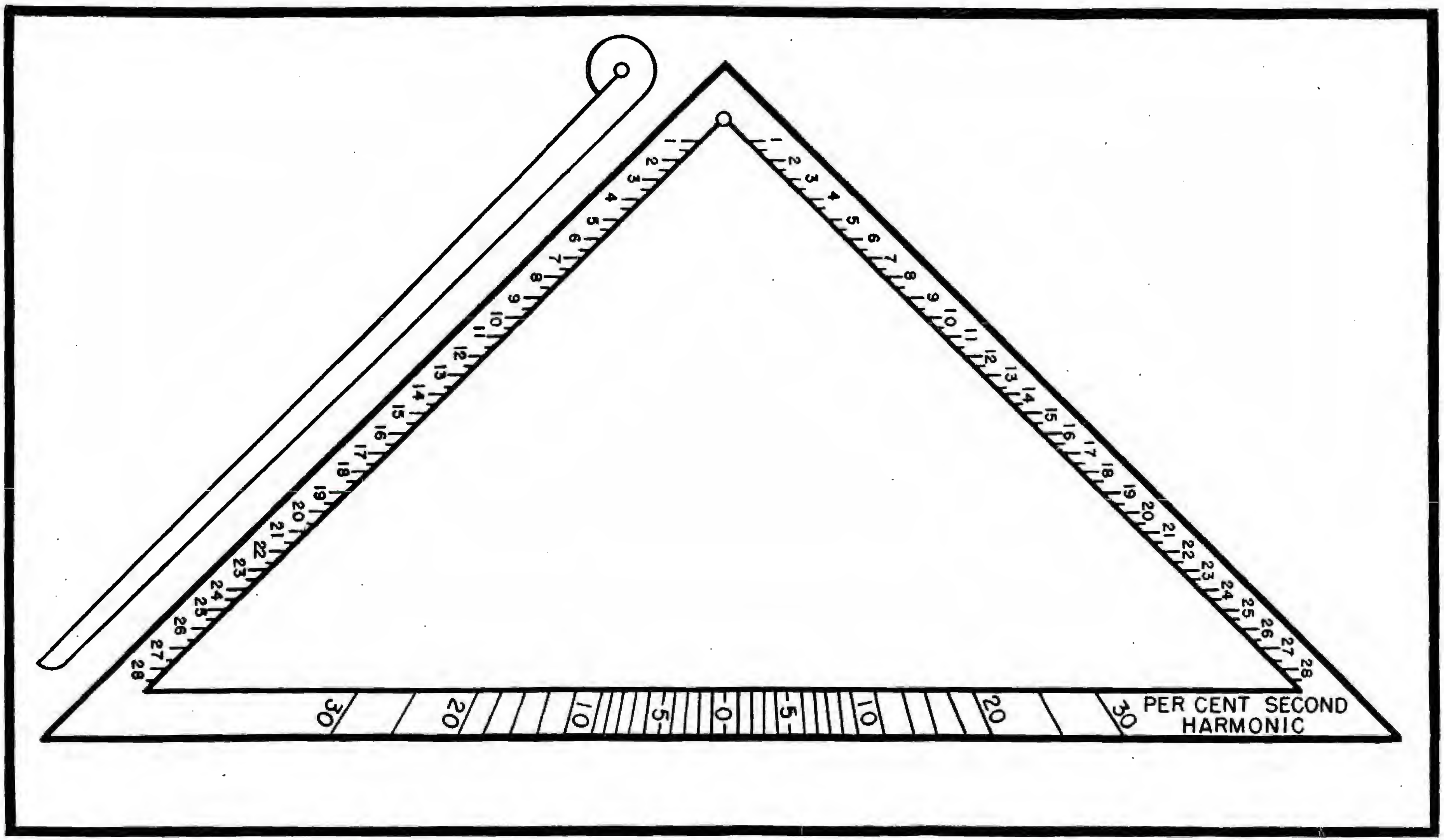
Figure 2
Pattern for calculator designed to expedite evaluation of harmonics. Model shown here is of cut-out type. Calculator can also be built on lucite with vertical lines etched in to facilitate curve tracing.



Second Harmonic CALCULATOR

Calculator Permits Rapid Determination of Harmonic Distortion Directly from Graphical Construction.

by WILLIAM L. DETWILER

In the design of amplifiers, demodulators, and other devices employing non-linear components, it is frequently desirable to predict the harmonic distortion produced by a given design. When distortion is a critical factor, graphical constructions are often used to obtain data for distortion computations.

In the graphical design of amplifiers, a family of E_p-I_p curves is usually employed. An illustration of the use of these curves for a triode amplifier having a simple resistance plate load is shown in Figure 1. In this case the line *AF* is drawn from the point *F*, representing the plate supply voltage, at an angle Θ, determined by the resistance of the load *R*. The curve representing the grid bias to be used will intersect *AF* at a point *C*, which is termed the *operating point*. The points *B* and *D* are determined by the intersection of *AF* with the curves representing the maximum and minimum values of instantaneous grid voltage. The coordinates along *BCD* are the voltage and current in the load *R* for the various grid voltages, and *BCD* is therefore often referred to as a *load line*.

When the above type of construction is used, the approximate percentage of second harmonic distortion can be found by the formula:

$$\frac{\%\ \text{Second Harmonic}}{\text{Fundamental}} = \frac{\frac{1}{2}(I_{max} + I_{min}) - I_o}{I_{max} - I_{min}} \times 100 \quad (1)$$

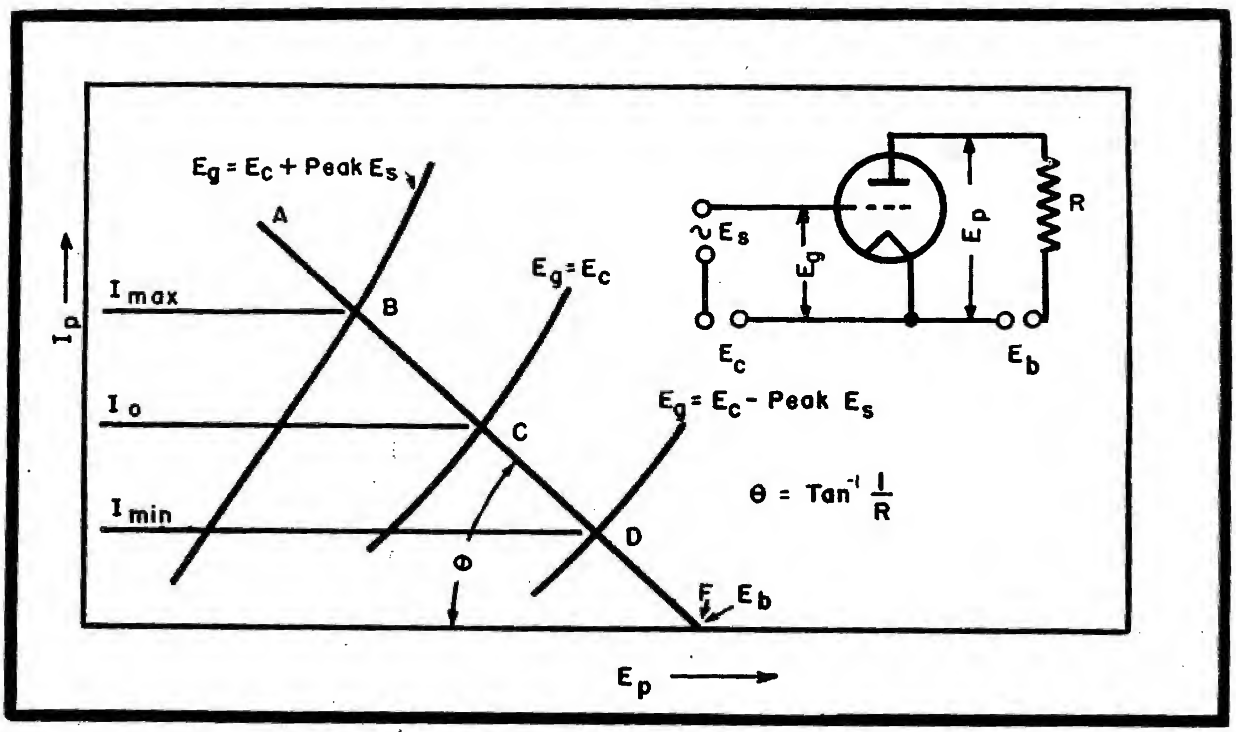
Determination ot third and higher harmonics is also possible by well known means, but the necessity of determining the large number of points needed in the computation makes it difficult to obtain accurate results.

In single-ended amplifiers where the dynamic characteristic has no sharp bends, second-harmonic distortion will be the most prominent and equation (*1*) will be sufficiently accurate for usual engineering purposes, with the notable exception of pentode amplifiers operating into high-resistance loads. In triode amplifiers operating at low distortion levels, the amplitude of the higher harmonics is usually so low that the value of second harmonic

(*Continued on page* 28)

Figure 1

Family of curves (E_p-I_p) for a triode amplifier having a simple resistance plate load used in graphical design of amplifiers.



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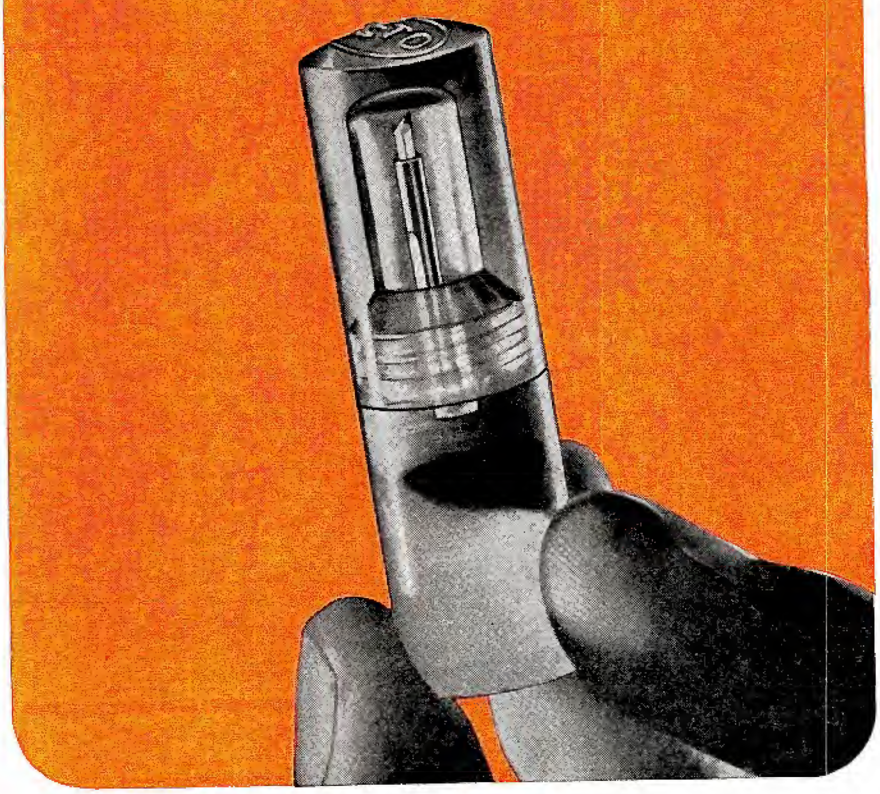
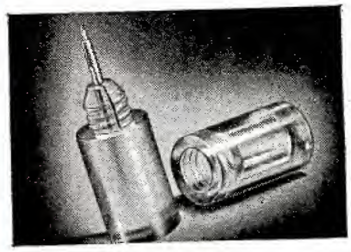
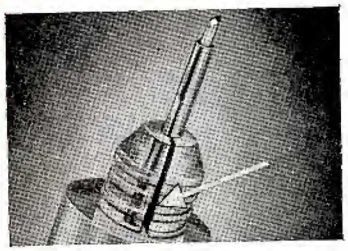
at no extra cost





NEW! A transparent lucite container keeps Presto Cutting Needles *safe*. Nothing can harm the precision ground point and cutting edges.



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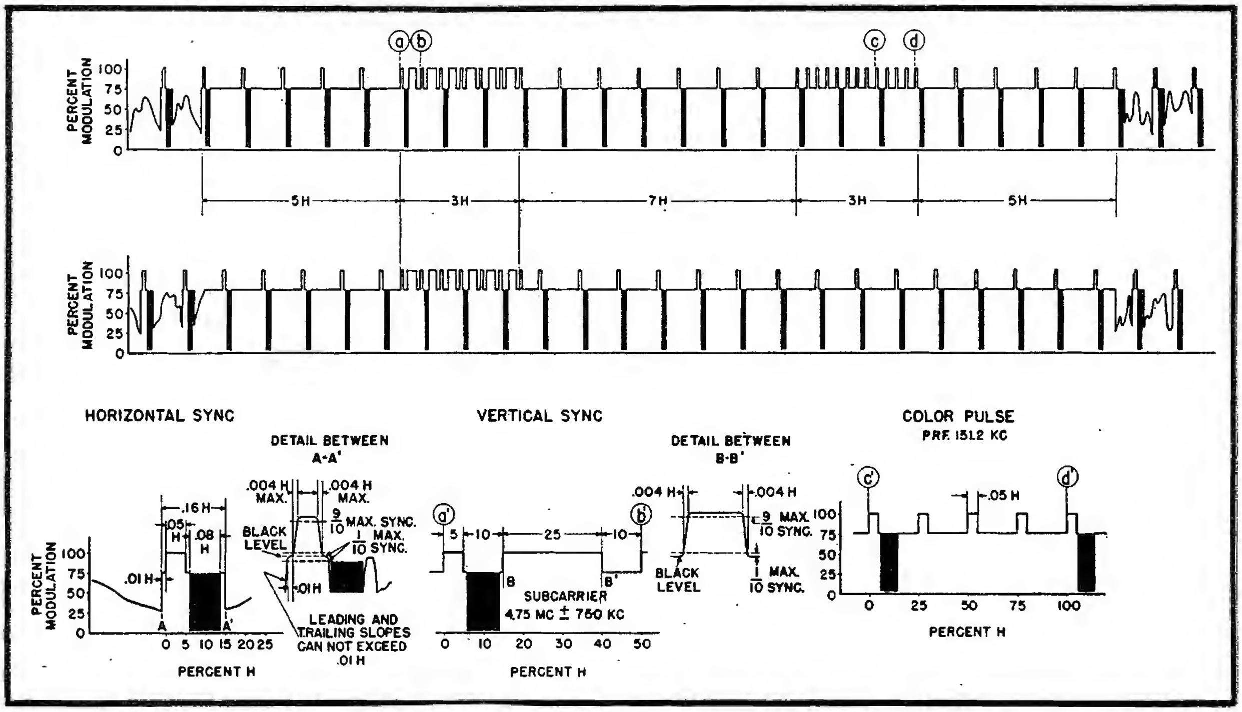

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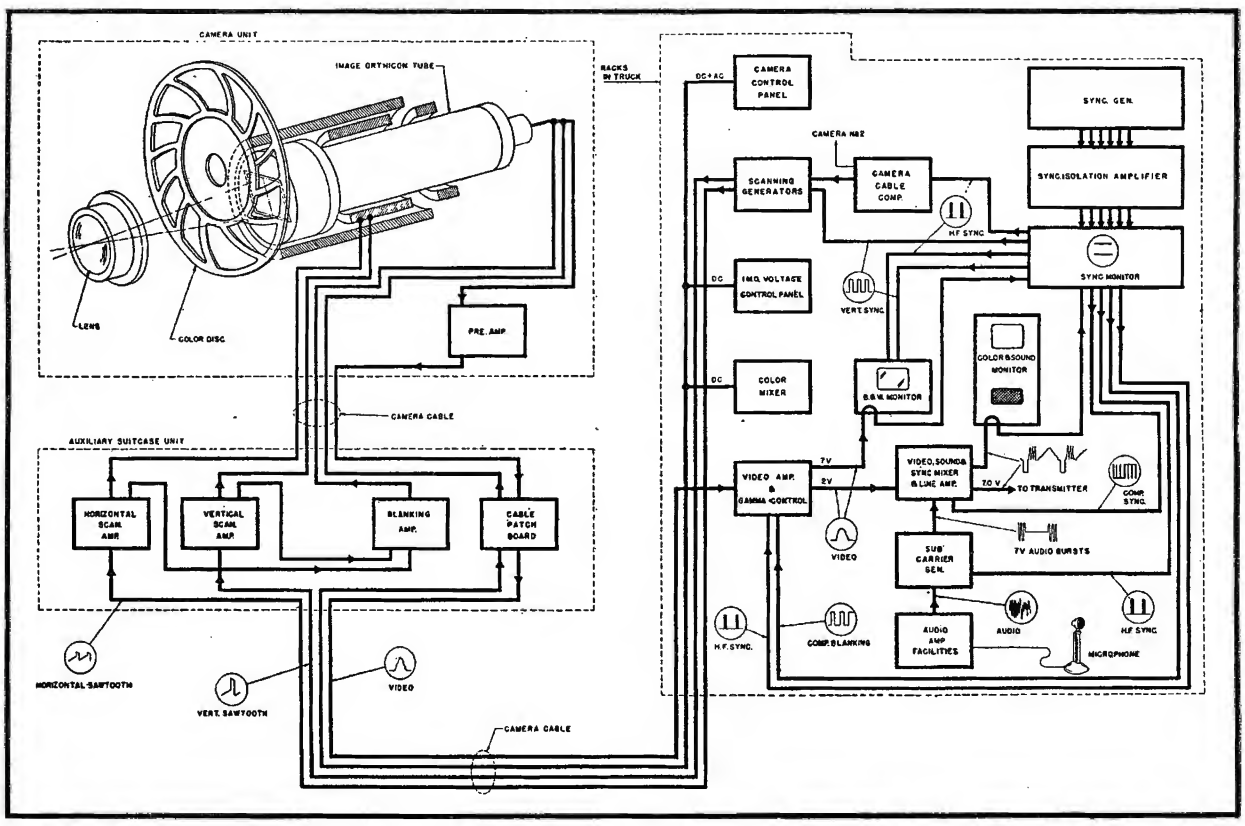


bility characteristics of 100-kc crystals are rather well known. In general, crystal aging averages less than ±.01% over a period of several months.

Power Supply

Most general-purpose laboratory instruments are used in setups with other equipment and are usually tied to a common ground point. To avoid differences in chassis potentials, it is important that complete isolation from the line be obtained through use of a transformer. Bypassing both sides of the a-c line to chassis should also be avoided, since the capacity divider thus created elevates the chassis well above ground potential. Not only is a transformer-type power supply used in this frequency meter but the output voltage has excellent regulation. Additional gas-tube regulation is employed for the crystal and calibrated oscillator stages.

Coupling Means

Readily adjustable coupling to the instrument from radiated signals is obtained through a five-section 24″ telescoping antenna mounted on the instrument case. Direct connections may also be made to this antenna. A ground terminal is provided which is entirely isolated from the a-c line.

An input signal of 1-millivolt amplitude is required for routine measurement.

The tunable oscillator is carefully calibrated at 10-kc intervals by use of external laboratory equipment. If the 100-kc crystal oscillator is then allowed to beat against the tunable oscillator, an audio note is available at the headphone jack. Three strong zero-beat points are obtained per band. These points are located at even 100-kc intervals, i.e., 1.0, 1.1, 1.2 mc on the first band; 1.2, 1.3, 1.4 mc on the second band, etc. A three-point check is thus obtainable, which permits the original calibration curve to be exactly reestablished. The calibrator may be turned off and an unknown signal compared with the calibrated tunable oscillator. The same mixer and audio-frequency amplifier is employed for frequency measurement as for calibration.

Tunable Oscillator

The most essential requirement of the tunable oscillator is that it remain stable despite sudden line-voltage fluctuations, or ambient-temperature changes. Long-time stability is much less important, since the crystal oscillator may always be relied upon for standardization. The well-known electron coupled oscillator with separate tuned circuits for each band was selected for this instrument. All trimmer capacitors employ air dielectric and coil forms are grooved for highest stability. All tuned circuits are shorted to ground except for the particular range in use. Anode voltages are regulated.

The mixer circuit uses one-half of a dual triode, the other half being the audio stage. All r-f signals are fed to a point of low impedance for audio frequency before being fed to the mixer

(*Continued on page* 29)

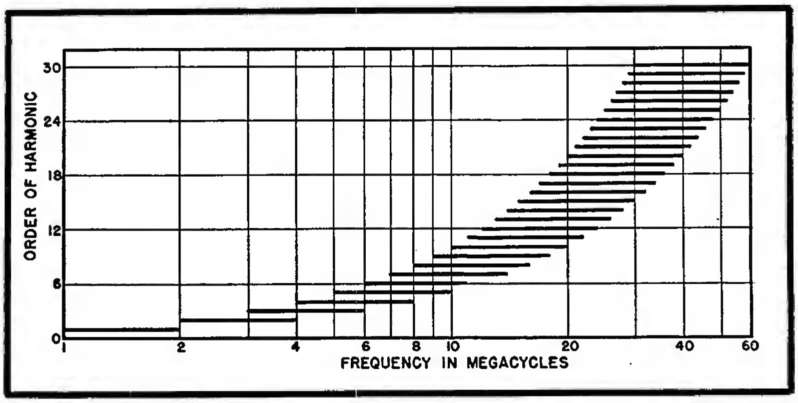


Figure 1
Harmonic frequency coverage of a 1 to 2-mc oscillator.

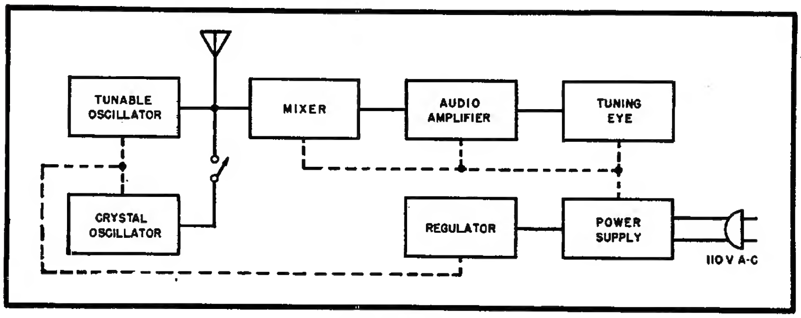
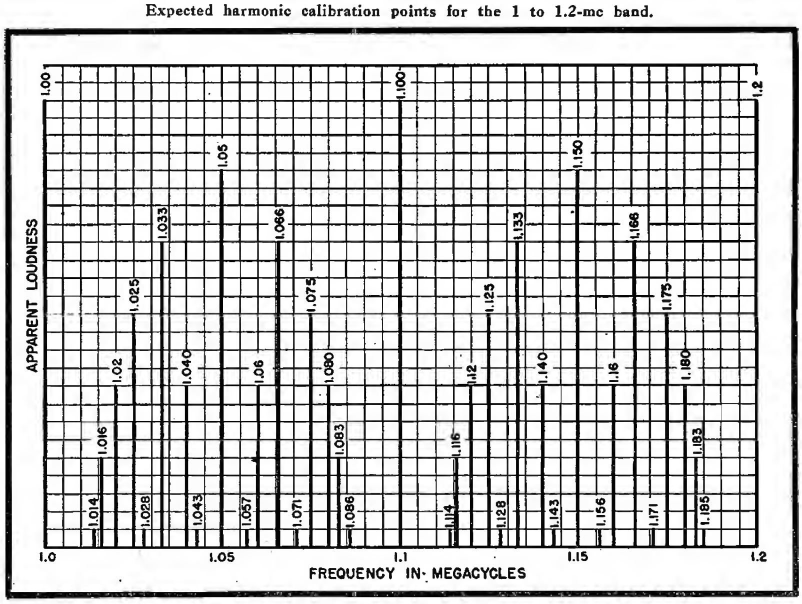


Figure 2
Block diagram of frequency meter.

Figure 3
Expected harmonic calibration points for the 1 to 1.2-mc band.



A-C MEASUREMENTS of Magnetic Properties*

by HORATIO W. LAMSON

Engineer, General Radio Co.

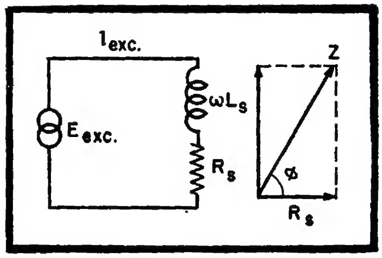


Figure 1
Usual conception of iron-core conductor consisting of series inductance L_s and series resistance R_s.

A COMMON PROCEDURE for measuring magnetic properties has been to consider that an iron-cored inductor (Figure 1) consists merely of series inductance L_s and series resistance R_s. For the purpose at hand such a representation is unsatisfactory since it leads to the *erroneous* conclusions that the exciting current leads the induced voltage by 90° and thus, being in phase with the flux, creates the magnetizing force.

An examination of the existing phases demonstrates the true relationships, Figure 2. The total exciting current must be considered to be the sum of two components—the magnetizing current I_m in phase with the flux and creating the magnetomotive force, and the loss current I_l in phase with the exciting voltage and thus responsible for the core losses due to hysteresis and eddy currents. It will be noted that the exciting current leads the magnetizing current by the hysteric angle β. The terminal voltage E_T is likewise the sum of two components—the exciting voltage, which is equal and opposite to the induced voltage; and the voltage E_c, which is in phase with the exciting current and thus responsible for the copper loss. Finally, the terminal voltage leads the exciting current by ϕ, the phase angle of the inductor.

To meet these conditions, the inductor must be represented by the reactance, $\omega L'$, carrying the magnetizing current and in parallel with the core-loss resistance, R′, carrying the loss current. This combination is then in series with the copper-loss resistance, R_c, which carries the full exciting current and which, at low frequencies (60 cps), may be considered to be the d-c resistance of the winding.

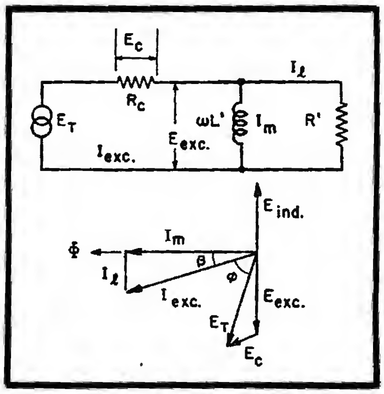
The true value of the magnetizing current is thus given by

$$I_m = I_{exc} \cos \beta$$

which demands a knowledge of the hysteric angle to evaluate magnetic data correctly. In cases where copper-loss is negligible, E_c vanishes, E_T equals the exciting voltage, and β becomes the complement of ϕ.

The system shown in Figure 3 has been devised to study magnetic core specimens. The exciting current is evaluated from the measured voltage, E_R, across a known external resistance, *R*, in series with the inductor. The exciting voltage is either the measured terminal voltage, E_T, in the upper diagram (when copper-loss is negligible), or is the voltage, E′ (lower diagram), induced in a secondary winding allowing for the turns ratio. The normal permeability of the core material is then given by

Figure 2
Time relationships when existing phases are studied; total exciting current must be considered to be sum of two components, magnetizing current I_m and loss current I_l.



$$\mu = \frac{10^8 \lambda R E_{exc}}{5.03 N^2 A f E_R \cos \beta}$$

where E_R is the *peak* voltage across *R*, and E_{exc} is the *average* value of the exciting voltage. *A* is the uniform cross-section of the core in square centimeters and λ is the mean flux path length in centimeters, while *f* is the exciting frequency and *N* is the number of turns of the primary winding.

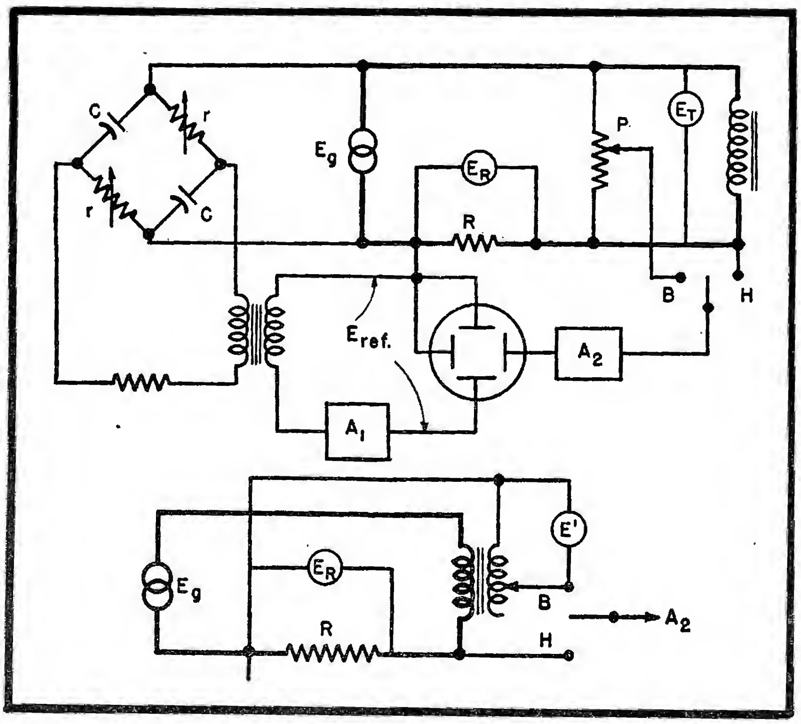
To measure the angle, β, the two voltages, E_R and E_{exc}, are phase-matched separately on a cathode-ray oscillograph against a reference voltage. For this purpose the phase of E_{ref} may be adjusted by means of the *calibrated* phase-shift network composed of the equal variable resistors, *r*, and the equal fixed capacitors, *C*. The phase displacement angle, α, of this network may be obtained from

$$\tan \alpha = \frac{2\,m}{1 - m^2}$$

wherein *m* is the ratio of *r* to the reactance of *C*. Thus from the difference between the two α values the phase angle between the exciting current and the exciting voltage, which is the complement of β, may be determined.

The reference voltage is suitably amplified by A_1 while the two voltages, E_{exc} and E_R, obtained alternately by the *B* and *H* positions of the switch are magnified by the amplifier A_2 which is set for the same arbitrary gain in both cases. *P* is an adjustable high-resistance voltage divider drawing a negligible current through R.

Figure 3
Circuit of method derived by Mr. Lamson to study magnetic core specimens.



*From a paper presented at the Rochester Fall Meeting.

TELEVISION And F-M PLANS For Canada*

by G. W. OLIVE

Chief Engineer
Canadian Broadcasting Corporation

Long-Term Plans Recently Disclosed Include Wide-Area U-H-F Relay Networks, Dual-Language Programs, and Provision for 25-Cycle Service in Such Areas as Toronto.

THE PROBLEMS associated with the setting up of a television service are both economic and technical and these, I am sure, will be a challenge to the radio and electronic industry in Canada. Insofar as it is within their province, they will, as in the past, do their part in helping to establish, when feasible, the physical requirements for a television service.

From September, 1939, to the end of the European war, the radio and electronic manufacturing industry in Canada expanded in dollar volume of business from about $35,000,000 annually in 1940 to a volume of about $100,000,000 annually in 1941 and reached a peak about 1945 of approximately $225,000,000. This dollar volume of business may not seem large when compared to that for other countries, such as the United States, for the same period; but we must remember that, although Canada covers an area actually greater than that of the continental United States, and stretches through five time zones east to west, a distance of nearly 3,500 miles, it has a population today of only about 12,500,000.

Canada's National Research Council, in conjunction with Research Enterprises Limited, made important contributions to radio and electronic research working, of course, in closest cooperation with similar groups in Great Britain and the United States.

While the Canadian manufacturing facilities were being expanded for war purposes and research and development were likewise being engaged, the production of radio equipment for other than direct war use was practically at a standstill for over six years. Because of this, the broadcasting business in Canada today has built up a considerable backlog of peace-time demands for new transmitters, domestic receivers and associated facilities. Some fifty-five Canadian broadcasting stations will increase power during 1946 and early 1947 and some twenty new a-m broadcasting stations will be built. Included in this group are three 50-kw, one 10-kw and thirty-five 5-kw transmitters, and miscellaneous units of lower power. In addition, many new f-m stations are expected to go into operation in 1946 and 1947. Of course, this after-war demand of broadcasting represents but a part of the total Canadian business that must be dealt with by the radio and electronic manufacturing industry in Canada at this time. Police, fire, forest, utilities, railways, highways, marine, navigational aids, aeronautical radio and industrial electronics have all special service requirements. I am advised that total existing demands in this industry may not be fully met before the fall of 1947.

In Canada, under the Canadian Broadcasting Act of 1936, the CBC is responsible to Parliament and hence to the people of Canada for exercising certain supervisory controls over radio broadcasting. Under the same Act, broadcasting means:

> "The dissemination of any form of radioelectric communication, including radiotelegraph, radiotelephone, the wireless transmission of writing, signs, signals, pictures and sound of all kinds, by means of Hertzian waves, intended to be received by the public either directly or through the medium of relay stations."

Unlike the United States and Great Britain, Canada had not commenced to operate a television service prior to the outbreak of war. At that time (1939), we were engaged in expanding, and improving sound broadcasting facilities across Canada and were only just considering the use of f-m broadcasting to supplement the a-m system, following some experimental work carried out near Ottawa in the 40-mc band in 1936

The broadcasting industry in Canada undoubtedly will look to the CBC to initiate a television service. Some considerable attention has been paid to the peculiar problems associated with Canada's geographical and economic position on the North American Continent.

According to the 1941 census, the total population of the Dominion of Canada was approximately 11,500,000. The population within a 30-mile radius of Radio City, New York, according to the 1940 census, was approximately 11,700,000 (One television station in New York City could have a greater potential audience than the total population of Canada).

So we have the population of Canada about equal to that of metropolitan New York but spread out in an area over a thousand times greater. (3,500,000 square miles for Canada—2,560 square miles for metropolitan New York; 3½ people per square mile for Canada—4,565 for New York). The retail sales volume, or spending power for domestic consumer goods, for 1941 for Canada was $3,440,902,000 and for metropolitan New York (1940) $4,919,462,000. The radio homes for 1941 for Canada were 2,712,000 and for metropolitan New York, according to the 1940 census, 3,057,000. I understand the population of Canada today is about 12,500,000. The rate of growth now from native-born population is about 1½% or 200,000 a year, but it is expected that the figures for population and retail sales volume, radio homes, etc., today would bear about the same relation with metropolitan New York as for 1940-41. Or we can compare the land areas with that of England where television plans are now well advanced. The whole of the population and land area of Britain, including England, Wales and Scotland, can be confined to an area extending from Montreal to Windsor and about 150 miles wide. This particular area is one of the most densely populated in Canada but, even then, the Canadian population would be something like 5,000,000 as compared to over 45,000,000 in Great Britain.

And so we have, as the most serious problem facing us in the introduction of television, this very important matter of great distances and relatively small population. In the most populated areas of Ontario, Canada's largest and wealthiest province, there is a 25-cycle power region known as the Niagara Division of the Ontario Hydro Electric Commission. The population served by 25-cycle supply represents about twenty per cent of the total population of Canada and about twenty-seven per cent of the retail buying power of the country. This is the area in which television undoubtedly should first be introduced because the density of population and per capita wealth would justify it. To date very little technical information has appeared on the subject of television operation on 25-cycle power systems. There are some problems introduced, of course, not found in 60-cycle areas. Insofar as 25-cycle operation of a television receiver itself is concerned, there would be the additional bulk of the power supply and an additional amount of filtering required to reduce hum to very low level. This, of course, would mean more cost to the purchaser of a 25-cycle television receiver.

The Commission plans to make the 25-to-60-cycle change, but some twenty years will be required to complete the installations. Our planning for at least the next five years will include 25-cycle power systems.

At the transmitter end, the cost of the 25-cycle power supply will be higher than that for 60-cycle supply. This is aggravated by the necessity of improving the filtering beyond that which would ordinarily be required from a 60-cycle source. It may be that, in such 25-cycle areas, rotary converters will be employed with power supplies operating at higher frequencies.

Then, at the studio, there is the prob-

From a paper presented before the Rochester Fall Meeting.

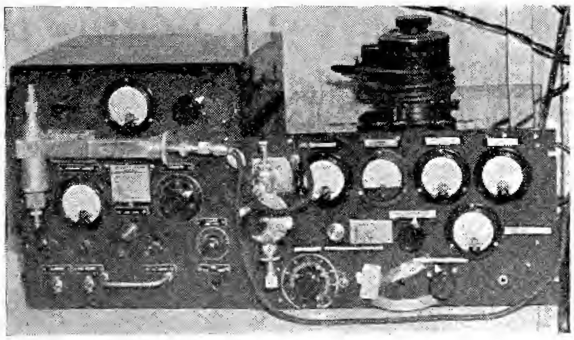


Figure 2
Calibrating signal generator, receiver, and recording equipment used in Canada for tests on the proposed Hamilton-Toronto-Ottawa-Montreal radio relay system.

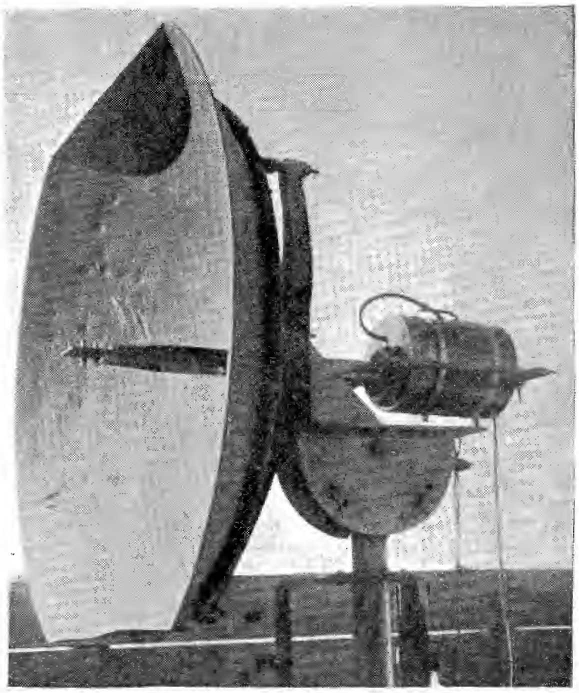


Figure 1
Parabolic reflector operating at approximately 3,000 mc used by CBC during experimental television setup tests.

lem of studio lighting. It does not appear probable that we could use 25-cycle power for the lighting system in television studios because the flicker would be too severe. All this means that, in an area that could best afford to pay for television, and in which television might first be introduced, there are certain special technical problems which must be dealt with and the cost, both to the television operator and to the ultimate user of the service, is going to be higher than would otherwise be the case in a 60-cycle area.

Montreal, the largest city in Canada with regard to population and purchasing power, fortunately is outside the 25-cycle area in Ontario, but there we have the problem of two languages and two cultures and different racial origins. At the present time, the CBC is operating two English networks and one French network through Montreal but over three-quarters of the population of greater Montreal are of French origin.

There are in Canada some seventeen major market areas. Of these seventeen market areas, four of the most important lie within the 25-cycle power region in Ontario. The largest single market area is Montreal where we have the dual language problem and, the other areas which do not have the language problem or that of power supply, are located at great distances from the important centres of population in Montreal and Toronto.

When the CBC began to actively plan its post-war expansion program in 1944, one of the first considerations was the extent to which f-m would be employed to supplement and improve the existing sound broadcasting facilities in Canada. Surveys were carried out in important centres. In Montreal, a site was selected on top of Mount Royal in the centre of the city and, at that time, plans were prepared for a building to include space for television and f-m transmitters. Similarly, in Toronto, a site has been obtained in the Bank of Commerce Building, the highest in the city, and an f-m transmitter is now installed there and space will be available for initial experimental television operation as required. In all, the CBC will install seven f-m transmitters across Canada and, at the locations chosen, sites will also be available for experimental television service.

In our initial planning for postwar expansion, consideration was given to the possibility of establishing an initial television service at some five locations in Canada. It was thought, because of the difficulties to be encountered in the 25-cycle area, that the first installation would be made in Montreal and at the site selected on Mount Royal. It has been realized that, even in the experimental stages, some facilities would be needed for linking up such important centres of television programming as Toronto and Montreal.

The communication departments of the Canadian Pacific Railway Company and the Canadian National Railways who jointly supply the CBC with network facilities are now exploring the application of radio relay systems. Field surveys and propagation tests have already been made for microwave system linking Montreal, Ottawa and Toronto. A complete system, including multiplexing equipment for the derivation of telegraph, telephone and program transmission channels, will shortly be placed in operation between Toronto and Hamilton, Ontario.

The plans place special emphasis upon the development of high-fidelity program transmission channels over these relays and will be broadened to include consideration of television relay channels when required. Thus far twelve sites have been selected for unattended intermediate repeaters for the Montreal, Ottawa, Toronto route, with an average spacing of thirty miles.

The ultimate aim of the companies supplying the service is to provide a facility that will take care of considerable commercial traffic besides the requirements for high-fidelity sound broadcasting networks or television.

It is obvious that, at this stage, the planning of a national network television service in Canada would be simply wishful thinking. With a population of some 20,000,000 or more people, Canada will be much better able to afford a national television service and it may not be too much to hope that such a service will be feasible within the next ten to fifteen years.

In Montreal and Toronto, where the CBC will likely start its initial television service, two of the problems peculiar to Canada will arise:

(*1*) In Montreal, language and cultural differences requiring dual programming and eventually dual transmitter equipment.

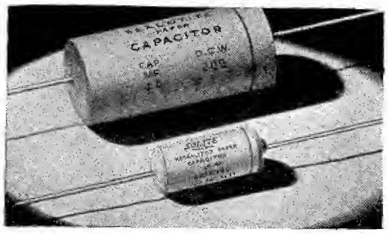
(*2*) In Toronto, 25-cycle power supply.

We realize that television might be the ultimate in broadcasting—adding sight to sound may be compared in broadcasting to the adding of sound to sight in the movie industry some twenty years ago. But, in television, there is one thing that we in Canada must keep in mind—whatever we do is going to be costly so that, when a start is made, it must be in the right direction from the standpoint of minimum cost, value of service to be given, and usefulness in the future.

And, finally, when will television start in Canada? Well, it may be fairly soon. The CBC Board of Governors has already informed us that a study of a Montreal-Toronto television service has been authorized.

Papers and highlights of Rochester Fall Meeting papers presented by Mr. Olive; H. W. Lamson; Sarkes Tarzian, A. Valdettaro and M. Weigel, and J. I. Cornell appear on this and the following pages: 19, 22, and 27.

Highlights of Fall Meeting papers presented by Reedy, Guy, Dome, Hill and Lebenbaum appeared in December, 1946, COMMUNICATIONS.



Comparison of sizes of standard type paper capacitor and metallized paper capacitor.

METALLIZED Paper Capacitors*

by JAMES I. CORNELL

Vice President in Charge of Engineering Solar Manufacturing Corp.

CAPACITORS[2] USING self-healing metallized paper construction instead of the conventional multi-paper and foil construction were recently developed in our laboratories.

In these capacitors pure aluminum electrodes are applied to the dielectric by means of a high vacuum vaporization process. The resultant capacitors are considerably reduced in size and are also self-healing.

Conventional Construction

Before discussing these capacitors more fully, it may be well to review briefly the construction of conventional paper capacitors. Standard impregnated paper capacitors consist basically of windings of two 0.00035″ metallic foils separated by a minimum of two or more plies of Kraft capacitor tissue. The multiple-ply dielectric is employed so that there will be little chance of failure from metallic particles or weak spots in the tissue. The probability of coincidence of weak spots in two papers is very remote.

Metallized Paper Construction

In the new type capacitors there is no foil. The capactor electrodes are, instead, 25 to 100 millicron thick metallic coatings deposited on the paper. The thin film contributes the property of *self-healing* to capacitors, permitting the use of a single sheet dielectric. During the course of processing metallized paper, metal inclusions in the paper and weak spots in the tissue are removed, allowing the single tissue to be worked at its maximum electrical stress.

Therefore these metallized paper capacitors will not break down at its rated working voltage until a weak spot develops in the dielectric. This should happen very rarely during life. However, if it does happen, the resulting arc discharge through the paper removes the weak spot and at the same time vaporizes the aluminum film around the weak spot, clearing the fault. The aluminum is redeposited as aluminum oxide, an excellent insulating material. Thus, the property of self-healing which assures the large factor of safety.

For voltage ratings above 200 wvdc, multiple layer or interleaved constructions are used. The volume and weight-saving is, of course, not as great as at the lower voltages but it is still considerable. At the same time, the self-healing characteristic is of great value.

Manufacturing Process

Ordinary capacitor tissue is treated with a coating of cellulose lacquer prior to metallizing in order to raise the breakdown voltage of the single-ply paper and to increase its insulation resistance. Coated paper is used for single-ply construction (200 wvdc rating or lower) while uncoated paper is customarily used for interleaved construction (above 200 wvdc) since the extra layer(s) of paper provides the required minimum insulation resistance and voltage breakdown strength.

The choice of aluminum for the metallic coating was made after extensive tests. A comparison of the boiling point of aluminum (1000° C at 10 microns pressure) with that of zinc (340° C at a lesser vacuum) may indicate one reason for the German use of a zinc film.

The metallic film thickness is adjusted to from 25 to 100 millimicrons, depending on the speed of the machine. Uniformity of the layer applied by the continuous coating process is excellent. In calculating the film resistance, the same specific resistance may be used as for pure aluminum. The coating is applied to the full jumbo roll width of the capacitor tissue.

To use the metallized paper in winding capacitors, it is first necessary to slit the paper into the required widths and to provide a non-metallized margin. The de-metallizing of the edge strip is combined with the slitting operation. Auxiliary metal roller discs are attached to a conventional slitting machine. The rollers are connected to a source of direct voltage. Passage of the paper under the rollers results in the removal of the metallic film in much the same way as in the process of *self-healing*. The paper is then slit in the center of the narrow path which has been completely cleared of metallic particles. The other edge of the capacitor tissue is slit directly through the metallized surface.

A patented non-inductive winding method is used. This method provides a positive connection between section and terminal pigtail.

During winding of the sections, the metallized edges of the capacitor tissues are edge-turned slightly to provide surfaces which can be bonded together by a metallic spray. Metal end caps, to which wire pigtails have been previously attached, are then soldered to the end surfaces of the capacitor sections.

It should be noted that it is necessary to mask the end surfaces of the sections so that the sprayed metal layer does not cover the entire end of each section. Otherwise, impregnation would be difficult and, in some cases, incomplete.

All metallized paper capacitors are made by the *dry assembly* method. Each section is assembled in its housing prior to impregnation. Impregnation is the final processing operation before test and inspection in the case of tubular designs for radio applications.

Two different impregnants are used, the choice depending on the operating requirements. Microcrystalline hydrocarbon wax is used for single layer windings and for multiple layer windings which are intended for operation at temperatures up to 70° C. Mineral oil is used for impregnating interleaved sections intended for use up to 85° C.

Thus far it has been impractical to employ chlorinated waxes or oils as impregnants for metallized paper capacitors. Halogenated impregnants have a tendency to break down under the arc discharges which take place during the self-healing operation. Consequently, it is necessary to employ stable impregnants which are unaffected by the self-healing operation.

While this would appear to place the metallized capacitors at a disadvantage because of the approximately two to one ratio of the dielectric constant of the halogenated waxes and oils commonly used to that of mineral waxes and oils, this is not actually the case. The size reduction realized through use of the single-layer construction or through the use of higher dielectric stresses in the interleaved windings more than makes up for the lower k of the impregnants used.

The impregnating compound also serves as the protective wax film over the entire assembly. This wax has quite superior moisture-resisting properties compared to the wax used in hitherto standard designs.

Rating		Dimensions in Inches	
		Metallized	RMA
Capacitance (mfd)	WVDC (Volts)	Length x Diam.	Length x Diam.
.1	200	5/8 x 3/8	1 5/8 x 1/2
.25	200	5/8 x 15/32	1 3/4 x 5/8
.5	200	1 1/8 x 15/32	2 x 3/4
1.0	200	1 1/8 x 17/32	2 1/2 x 7/8
.05	400	5/8 x 15/32	1 5/8 x 7/16
.1	400	1 1/8 x 15/32	1 5/8 x 9/16
.25	400	1 1/8 x 17/32	2 x 11/16
.5	400	1 5/8 x 5/8	2 x 7/8
1.0	400	2 1/8 x 11/16	2 5/8 x 1

Metallized-Foil Paper Capacitor Size Comparisons

*From a paper presented at the Rochester Fall Meeting.

[2]Solite.

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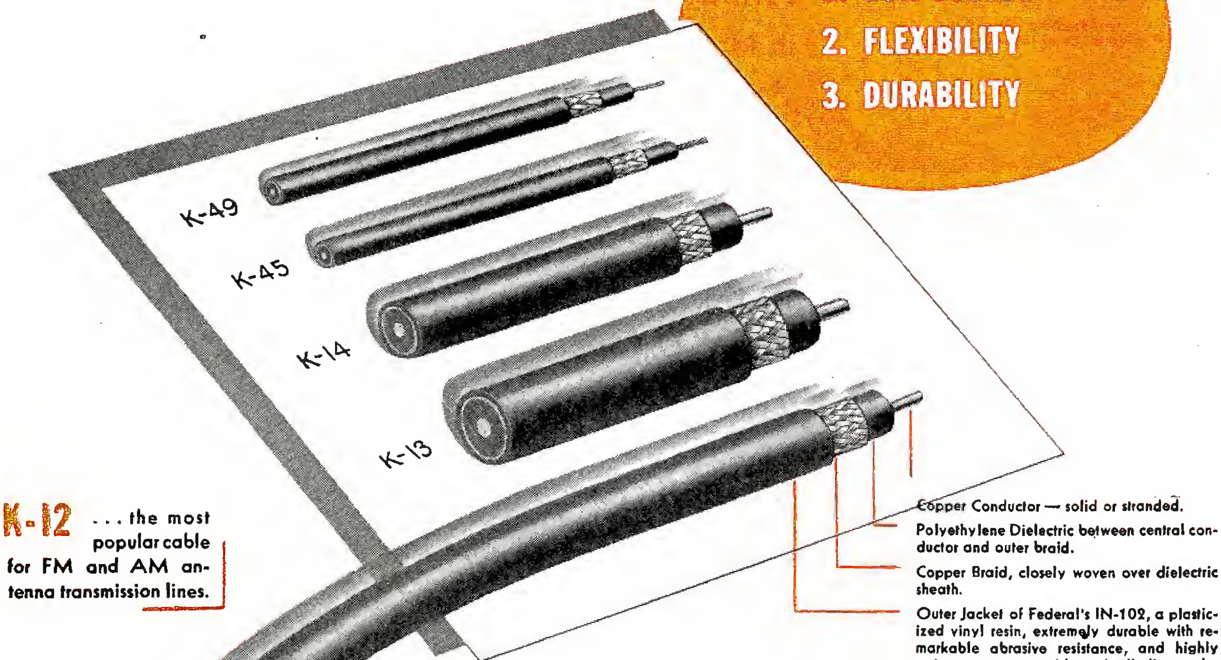

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High-Frequency Coaxial Cable Data

Type Number	Characteristic Impedance Ohms	Capacitance Per Ft. mmf	Attenuation Db. Per 100 Ft.					Power Rating Kilowatts					Physical Dimensions	
			Frequency in Megacycles					Frequency in Megacycles					Conductor Dia	O.D. Over Jacket
			1.0	1.7	30	100	300	1.0	1.7	30	100	300	Solid Copper	
K12	52	29	.066	.086	.425	.83	1.70	39	30	8.50	3.0	1.5	.188″	.885″
K13	52	29	.058	.076	.320	.69	1.45	51	43.8	13.5	5.4	2.3	.250″	1.135″
K14	71	21	.070	.092	.460	.93	1.90	36.5	27.8	5.55	2.71	1.34	.114″	.885″
													Stranded Copper	
K45	52	29	.155	.202	.900	2.1	4.20	13	9.9	2.4	.96	.480	.086″	.415″
K49	75	20	.182	.237	1.03	2.1	3.80	9.1	6.9	2.1	.79	.435	.048″	.415″

Federal Telephone and Radio Corporation

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Mobile F-M TRANSMITTERS

by N. MARCHAND*

Consulting Engineer
Lowenherz Development Company

Part XII Offers Analysis of Phase-Modulator Circuits Used in Mobile Systems.

In last month's discussion appeared a circuit diagram of a 50-watt mobile f-m transmitter that featured a phase modulator with a pair of 7A8s.

The modulator itself is rather interesting. The 7C7 is connected as a triode oscillator. The inductance in the tuned circuit in the plate of the 7C7 is center tapped to ground. One-half of the output voltage is directly applied to the top 7A8 modulator tube through the coupling capacitor, C_8. Also shunted across the center tapped inductance is a series circuit consisting of the resistor, R_3, and the capacitor, C_5. The junction of these two, *A*, is connected to the grid of the lower modulator tube. Inasmuch as the center tap of the inductance, *B*, is grounded, the voltage appearing at the grid of the lower 7A8 is the voltage from *B* to *A*. However it is a property of this type of circuit that as either the resistor is varied from zero to infinity ohms or the capacitor from zero to infinity microfarads, the voltage appearing across *B* to *A* will remain constant in amplitude, but the phase will vary from *in phase* with the voltage appearing on the grid of the upper tube, to *180° out of phase* with that voltage.

The actual phase relationship between the grid voltages of the two modulator tubes is not critical; a value between 90° and 170° is usually employed.

The circuit used in the modulator stage is similar to the ordinary balanced modulator. The audio modulating voltage is fed into them in push-pull so that as the upper output signal is increasing in amplitude, the lower signal is decreasing in amplitude. The outputs of the two modulator tubes are connected in parallel.

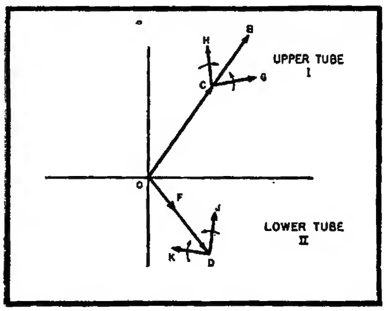


Figure 2
Phasor diagram illustrating the two output voltages of the modulator tubes shown in the circuit of Figure 1.

Phasor Diagram

An analysis of the circuit is presented in Figure 2. (To simplify this discussion, the upper modulator tube in Figure 1 has been called *I* and the lower tube *II*.) *OC* represents the carrier fed into tube *I* and *OD* represents the carrier fed into tube *II*. The resistor-capacitor combination is adjusted so that the carriers make an angle of about 120° to one another. Inasmuch as they are modulated in push-pull, the sidebands, *CH* and *CG*, cause the amplitude of the carrier in tube *I* to increase by the amount *CE* while the sidebands in tube *II* cause its carrier to decrease by the amount *DF*.

It will be noted that the direction of *DF* is such that it subtracts from the carrier, *OD*. The amplitude *OC* is always equal to the amplitude *OD* and the amplitudes of *CE* and *DF* are also equal but opposite in phase in relation to their carriers. These two modulated waves are added together in the outputs of the two modulators, as shown in the circuit diagram of Figure 1. The result is shown in the phasor diagram of Figure 3.

OM is the phasor which results from adding the two carriers, *OC* and *OD*, as shown in Figure 2. *MN* represents the modulation caused by the

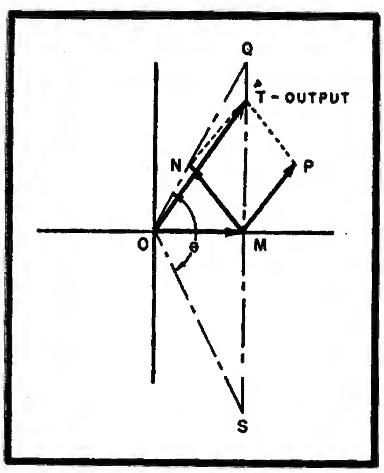


Figure 3
Phasor diagram indicating the addition of the two modulated waves shown in Figure 2. By using a distortion circuit in the audio input with a factor of 1/F the output is pure f-m.

List of parts for 50-watt transmitter shown in **Figure 1.**

C1	5000 MMFD	R1	470,000 OHMS
C2	50 MMFD	R2	1,000 OHMS
C3	100 MMFD	R3	10,000 OHMS
C4	2000 MMFD	R4	47,000 OHMS
C5	10 MMFD	R5	47,000 OHMS
C6	100 MMFD	R6	100 OHMS
C7	5000 MMFD	R7	4,700 OHMS
C8	20 MFD	R8	330 OHMS
C9	.05 MFD	R9	100,000 OHMS
C10	.05 MFD	R10	100,000 OHMS
C11	100 MMFD	R11	33,000 OHMS
C12	5000 MMFD	R12	33,000 OHMS
C13	2000 MMFD	R13	220,000 OHMS
C14	2000 MMFD	R14	100 OHMS
C15	100 MMFD	R15	1,000 OHMS
C16	2000 MMFD	R16	150,000 OHMS
C17	2000 MMFD	R17	220,000 OHMS
C18	2000 MMFD	R18	100 OHMS
C19	100 MMFD	R19	1,000 OHMS
C20	2000 MMFD	R20	160,000 OHMS
C21	2000 MMFD	R21	220,000 OHMS
C22	5000 MMFD	R22	100 OHMS
C23	2000 MMFD	R23	1,000 OHMS
C24	50 MMFD	R24	2,200 OHMS
C25	.05 MFD	R26	20,000 OHMS
C26	5000 MMFD	R27	22,000 OHMS
C27	2000 MMFD	R28	220,000 OHMS
C28	35 MMFD	R29	220,000 OHMS
C29	140 MMFD	R30	22,000 OHMS
C30	.01 MFD	R31	470 OHMS
C31	2000 MMFD	R32	5,000 OHMS
C32	2000 MMFD	R33	18 OHMS
C33	40 MFD	R34	22,000 OHMS
C34	2000 MMFD	R35	27,000 OHMS
C35	6 MFD		
C36	2 MFD		

**Instructor in Graduate Electric Engineering courses, Columbia University.*

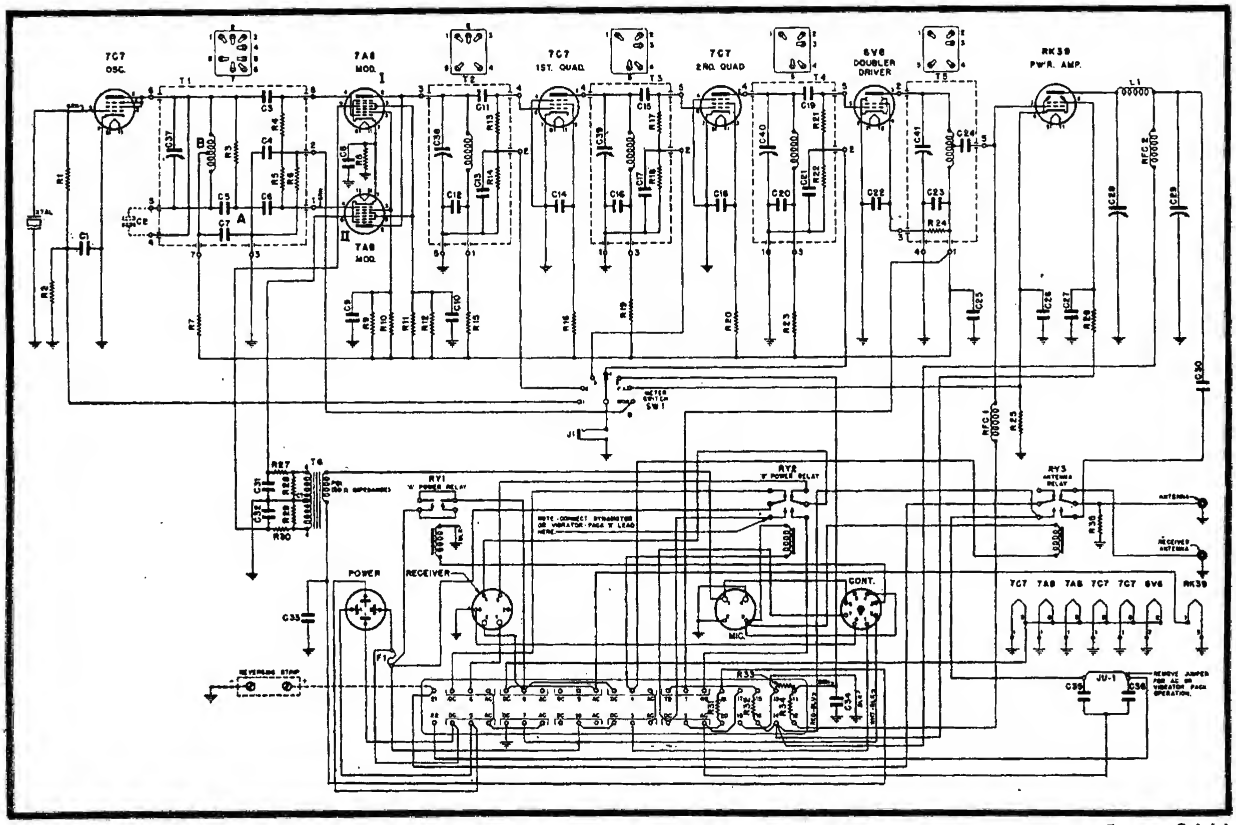


Figure 1 (*Courtesy Galvin*)

Circuit diagram of a 50-watt mobile transmitter using a crystal-generated, phase-to-frequency modulation method.

sidebands on tube *II* and *MP* represents the modulation caused by the side bands on tube *I*. These two phasors do not rotate but only vary in amplitude. They are equivalent to the phasors *DF* and *CE*, Figure 2. Adding *OM*, *MP* and *MN* the resultant phasor for the output is *OT*.

As *MN* and *MP* vary in amplitude from zero to maximum the output phase will vary between *OQ* and *OS*. The included angle indicated is Θ on the figure. By using a distortion circuit with a factor of $\frac{1}{F}$ in the audio input, the resultant output is actually frequency modulation.

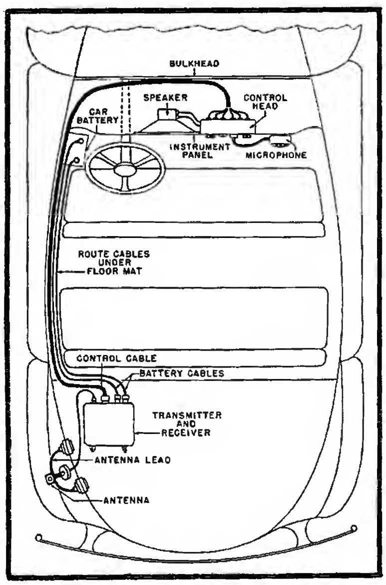
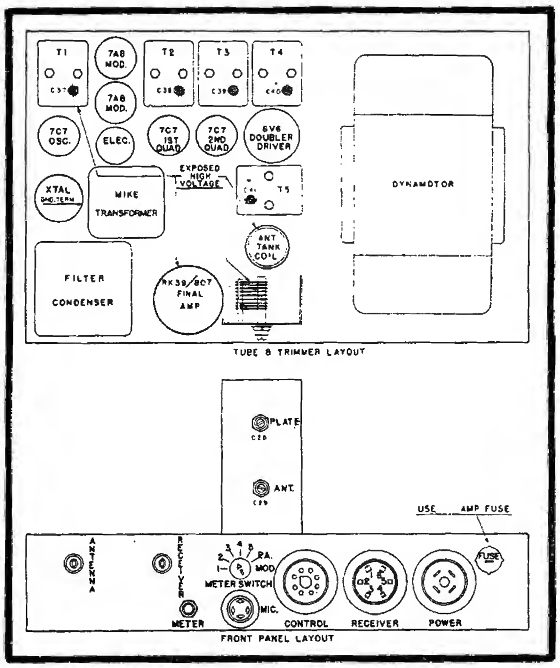


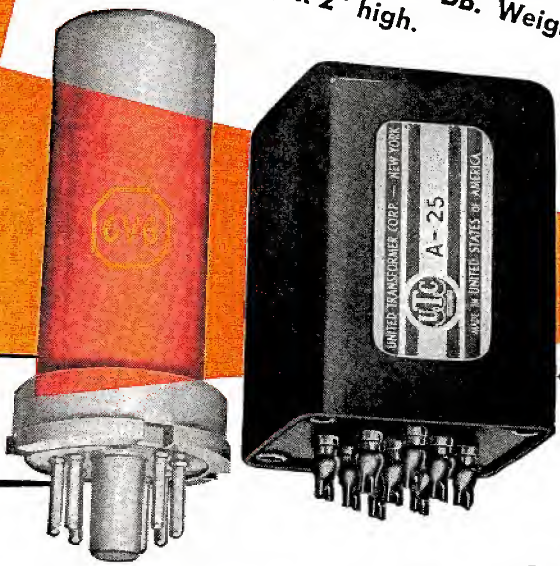
Figure 4 (left)
Transmitter cable layout of a 50-watt mobile transmitter showing the connections to the battery, antenna, control head, and microphone.

Figure 5
Tube and trimmer layout and the front panel layout of a 50-watt mobile transmitter.
(*Courtesy Galvin*)



For Compact High Fidelity Equipment

Ultra compact, lightweight, these UTC audio units are ideal for remote control amplifier and similar small equipment. New design methods provide high fidelity in all individual units, the frequency response being ±2 DB from 30 to 20,000 cycles. There is no need to resonate one unit in an amplifier to compensate for the drop of another unit. All units, except those carrying DC in Primary, employ a true hum balancing coil structure which, combined with a high conductivity outer case, effects good inductive shielding. Maximum operating level +10 DB. Weight–5½ ounces. Dimensions–1½" wide x 1½" deep x 2" high.



Unit shown is actual size. 6V6 tube shown for comparison only.

FOR IMMEDIATE DELIVERY

From Your Distributor

Ultra Compact High Fidelity Audio Units

Type No.	Application	Primary Impedance	Secondary Impedance	± 2 DB from	List Price
A-10	Low impedance mike, pickup, or multiple line to grid	50, 125, 200, 250, 333, 500 ohms	50,000 ohms	30-20,000	$15.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids	50, 200, 500 ohms	50,000 ohms	50-10,000 multiple alloy shield for extremely low hum pickup	16.00
A-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125, 200, 250, 333, 500 ohms	80,000 ohms overall in two sections	30-20,000	15.00
A-18	Single plate to two grids	8,000 to 15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio overall	30-20,000	14.00
A-24	Single plate to multiple line	8,000 to 15,000 ohms	50, 125, 200, 250, 333, 500 ohms	30-20,000	15.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	8,000 to 15,000 ohms	50, 125, 200, 250, 333, 500 ohms	50-12,000	14.00
A-26	Push pull low level plates to multiple line	8,000 to 15,000 ohms each side	50, 125, 200, 250, 333, 500 ohms	30-20,000	15.00
A-30	Audio choke, 300 henrys @ 2 MA 6000 ohms D.C., 75 henrys @ 4 MA 1500 ohms D.C., inductance with no D.C. 450 henrys				10.00

The above listing includes only a few of the many Ultra Compact Audio Units available . . . write for more details.

United Transformer Corp.

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EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y.

H-F A-M BROADCASTING For Small Communities*

by S. TARZIAN, A. VALDETTARO and M. WEIGEL

Consulting Engineers
Bloomington, Ind.

FOR A NUMBER OF YEARS it has seemed to a large number of engineers in the radio industry that a more economical way of using the high frequencies would be to have a-m. To test out this idea W9XHZ operating on 87.75 mc was erected in the beginning of 1946 in Bloomington, Indiana, with a population, exclusive of the student body at Indiana University of 11,000, of about 30,000.

The country is hilly. Within several miles of the transmitter there are hills whose height is greater than the average antenna height above sea level. These hills rise as high as 900 feet above sea level. The average antenna height is 795 feet above sea level. The territory is in the heart of the Indiana Limestone district so that just a few feet below the top soil limestone is encountered.

Transmitter

The transmitter, (Figure 1) built in our shop, has a maximum output of 500 watts; radiated power, 200 watts. In table 1 appears a tabulation of field strengths of the transmitter at varying distances.

Field Strength	*Distance from Transmitter*
10,000	1 mile
5,000	2 miles
1,000	4 miles
200	20 miles
50	25 miles

Table 1
Signal strength, μv/m.

The fidelity characteristics was specified as ±3 db from 30 to 10,000 cycles.

A 200′ self-supporting tower was constructed, with a 7′ x 8′ platform at the top of the tower to permit easy access to the antenna facilitating any changes necessary in trying out different types of antennas, feeders, etc.

Our first antenna, a north-south directional type, consisted of five half-wave dipoles.

The second antenna (Figure 2) non-directional and 42⅔′ long is the one now in use. It consists of eight co-axial units mounted vertically and hanging from the tower platform. Excellent results have been obtained with this unit. At Bedford, Indiana, 21 miles airline south of Bloomington, field strengths of 120 μv per meter have been measured.

Velocity microphones and magnetic pickup type turntables are used. Incidentally, all remote and studio control equipment was built in the shop.

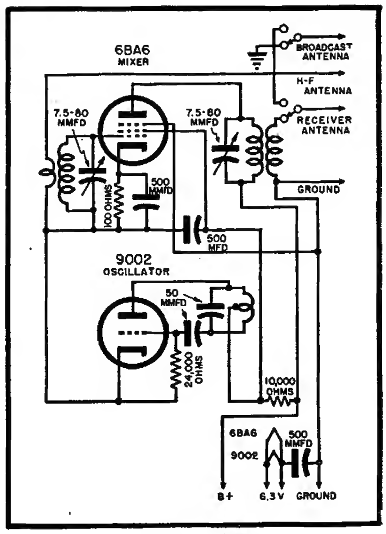


Figure 4
H-f a-m converter developed for broadcast receiver pickup of 87.75-mc signals from W9XHZ. Oscillator frequency, 86.25 mc. Oscillator plate coil, 2 turns of nilvar. Unit has gain of 25.

A compression amplifier is used to maintain a high modulation level.

Solid dielectric feeder lines, approximately 250′ long, are used between the transmitter and the antenna. A 2 to 1 loss in power occurs in the line.

H-f a-m was found to be free from multipath distortion in hilly country or where there are tall buildings.

A much narrower bandwidth than other systems can be used and therefore a greater number of stations can be assigned on a given frequency spectrum. The number assigned will depend on the highest audio frequency to be transmitted —5,000, 7,500, 10,000 or 15,000 cycles. If 5,000 cycles is the highest frequency then 20 stations could be operated on one f-m channel, where now only one f-m station operates.

We estimate that 400 kc (2 f-m channels) would take care of all small community requirements in the United States.

*From a paper presented at the Rochester Fall Meeting.

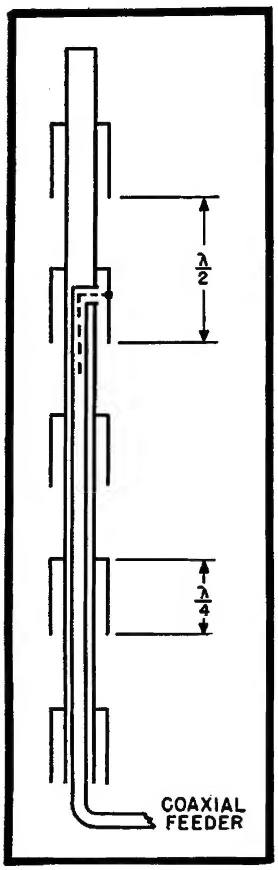


Figure 2
Vertical coaxial radiator, 42⅔′ long, now in use at W9XHZ.

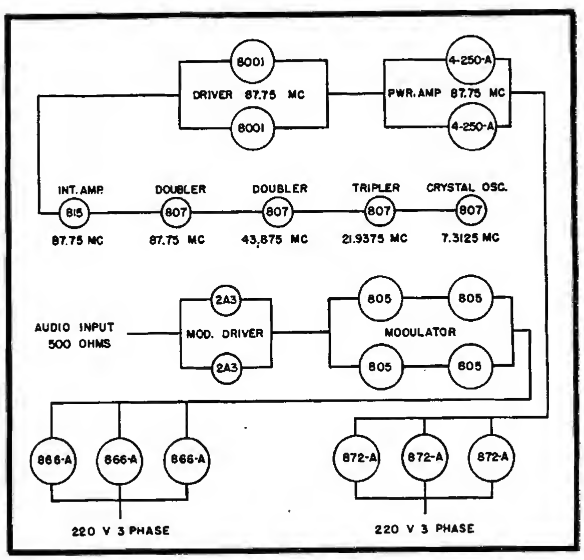


Figure 1 (right)
Block diagram of 500-watt a-m h-f transmitter.

CALCULATOR

(*Continued from page* 16)

is approximately equal to the total distortion and equation (*1*) can be used to give the percentage of total distortion.

While it is a simple matter to obtain the value of second harmonic distortion by substituting the voltage or current coordinates of points *B*, *C*, and *D* into equation (*1*), some method of rapid determination would be helpful, because the average design problem involves the trial of several different load lines.

The Calculator

A calculator can be used to make rapid determination possible. Such a device can be used because the harmonic evaluated in equation (*1*) can also be expressed as a function of the lengths of the two portions of the load line, *BC* and *CD*.

$$\frac{\%\ \text{Second Harmonic}}{\text{Fundamental}} = \frac{BC - CD}{2\,(BC + CD)} \times 100 \qquad (2)$$

A pattern for such a calculator is shown in Figure 2. Either of two methods can be used in construction. In one procedure a sheet of lucite or celluloid can be placed over the triangle of Figure 2, and the lines and figures transferred to the lucite or celluloid surface with a phonograph recording needle, filling in with India ink. In the other method, the triangle can be cemented to a cardboard and the area within the triangle cut out. The pointer is then made so that the bottom edge of the cutout is radial with the point of fastening, so that it can be used as a working edge.

In applying the calculator on the construction shown in Figure 1, it is placed over the load line *BCD* so that the ends of *BCD* touch the border lines of the calculator at like-numbered points. The pointer is then arranged to cross the operating point *C*, and the distortion read from the intersection of the pointer and the distortion scale.

In a similar manner, the calculator may be used to obtain second harmonic distortion directly from other graphical constructions involving a straight load line and a definite bias or operating point. In constructions in which the load line is not straight (e.g., a load line drawn on a tube dynamic or constant-current characteristic) the ends of the load line and the operating point can be projected onto the plate voltage or current coordinate of the graph and the projection used for the operation of the calculator.

FREQUENCY METER

(*Continued from page* 11)

grid. In this manner external hum pickup is minimized. The audio-frequency stage is entirely conventional and has good low-frequency response. The electron-ray tuning eye derives its excitation from the audio stage.

Crystal Calibrating Oscillator

In designing a highly-stable crystal oscillator, it is necessary to choose a circuit which is free from frequency change despite voltage variation, circuit aging, or tube replacement. Highly developed circuits have been designed which meet the aforementioned requirements to a high degree, though their complexity generally restricts their use to frequency standards. The circuit we used was designed to minimize frequency change in operation. Tube replacement must be compensated for, however, by retuning, since the tube input capacitance directly affects the crystal frequency. The method used to turn the crystal on or off avoids the necessity of either switching high-voltage leads, or placing a switch in the grid circuit.

Use

It was stated earlier that operating convenience was of great importance in designing any heterodyne-frequency meter. Most laboratory workers have become familiar with the great number of audible signals which may be obtained on a heterodyne-frequency meter which has appreciable frequency coverage. Identification of harmonics may become involved and, in some cases, discouraging. The logical approach to the problem is the measurement of the unknown frequency with a simple absorption-type wavemeter. Although such a measurement may only be accurate to a few per cent, it serves roughly to locate the frequency within the spectrum. Assuming, for example, that a rough measurement shows a signal at about 300 kc, we should expect the fourth harmonic to beat with the frequency-meter oscillator at 1,200 kc and the fifth harmonic at 1,500 kc. If we do find such signals at the proper point, we have verified the original measurement and may proceed to make accurate measurements with the frequency meter alone. We would logically expect that the lowest possible order of harmonics should produce the loudest signal. This verification is possible only if coupling to the fre-

(*Continued on page* 36)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. GEORGE H. CLARK, Secretary

Dinner-Cruise

THE TWENTY-SECOND ANNIVERSARY of the VWOA will be celebrated at the Hotel Astor, New York City, on Saturday evening, February 15, with a gala dinner-cruise. The *theme* of the dinner will be *United Nations Communications For Peace.* A feature of the evening will be the presentation of our Marconi Memorial Service Award Plaque to the United Nations. Several medals and other suitable awards will be presented to outstanding communications personnel of the United Nations. Members of each of the United Nations delegations have been invited to be present. Outstanding leaders of our armed forces and the communications industry also will be with us on this occasion. . . . Please send your reservations in early to William C. Simon, general manager of the Tropical Radio Service Corporation at Pier 7, North River, New York City. Tables of ten are available.

VWOA life member, William J. Halligan, president of Hallicrafters Company, receiving the War Department Certificate of Appreciation for the company's outstanding contribution to the war effort, from Col. Frank C. Kidwell, Signal Officer, 5th Army (left). Capt. T. S. Webb, 9th Naval District Communications Officer, is at right.

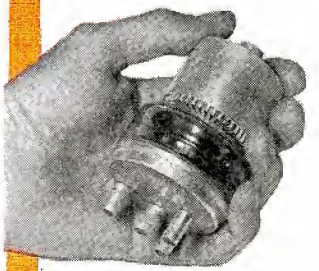
Personals

OUR SINCERE GOOD WISHES to all our members and friends for a Happy and Prosperous New Year. . . . A special word of appreciation to COMMUNICATIONS for their continued cooperation. . . . Leroy Bremmer, formerly secretary of the Los Angeles chapter VWOA was in New York recently. While here he completed the Radar course at the Maritime Training School and also was married. It was good to see him and learn that he will take charge of radio and radar aboard the Pacific exploration ship "Pacific Explorer." Good Luck, LB. . . . Nice seeing Admiral Joseph F. Farley, Commandant U. S. Coast Guard in New York recently. A former Chief of Coast Guard Communications, an honorary member of VWOA, we're mighty proud of our four star Admiral. . . . Veteran member Walter C. Evans, vice president of Westinghouse Electric Corporation in charge of all radio activities, has received the War Department Certificate of Appreciation for "his contributions to the Signal Corps in connection with the development and production of radio and radar equipment during World War II." Our sincere congratulations WCE. . . . All good wishes to Hal Styles, chairman of the Los Angeles chapter, for the success of his *Hal Styles' School of Radio* which will train personnel in all branches of broadcasting. A successful broadcaster of many years standing, with several outstanding radio programs to his credit, Hal is well equipped to do a creditable job in this new endeavor. . . . A long distance telephone chat with L. W. Bear, chairman of the Chicago chapter, revealed that the Chicago group plan having a dinner-cruise at the same time the New York dinner-cruise will be held, February 15. Members in the Chicago area may contact Mr. Bear at the Standard Metal Products Company, 4421 Carroll Ave., Chicago. . . . Received an interesting note from Otis Bartlett, Chief Wireless Operator and Officer in Charge at Belleoram, Fortune Bay, South West Coast, Newfoundland, which read . . . "While listening to your broadcast of medal presentations I was deeply moved. I had the honor of receiving your Association's Scroll of Honor for services rendered in March, 1931, at Horse Island, Newfoundland, in connection with the *Viking* disaster where two great American explorers perished, Varick Frizzel and A. E. Pinrod. I am still in the wireless telegraphic profession with the Newfoundland Postal Telegraph Department. I have a great desire to become a member of your Association if this is permissible. Please send application blank and details." . . . Life member Dr. Allen B. Du Mont recently demonstrated to a group of FCC officials the latest development of the laboratories he heads, the trichromoscope tube for video color reception. . . . Executive secretary "Bill" Simon will be glad to have those dues notices returned promptly with the necessary. . . . Life member George H. Clark is back in the saddle again after only a short retirement, and doing a splendid job on the 1947 Year Book, too. . . . Congratulations to life member Paul Forman Godley on the 25th anniversary of his outstanding long-distance radio communications achievement—the successful 200-meter transmission across the Atlantic to the specially selected receiving site on the bleak dismal Scotch coast at Ardrossan, Scotland. . . . Veteran member Lt. Col. V. A. Kamin is now located at Noroton Heights. Conn.

NOW THE 4X500A POWER TETRODE

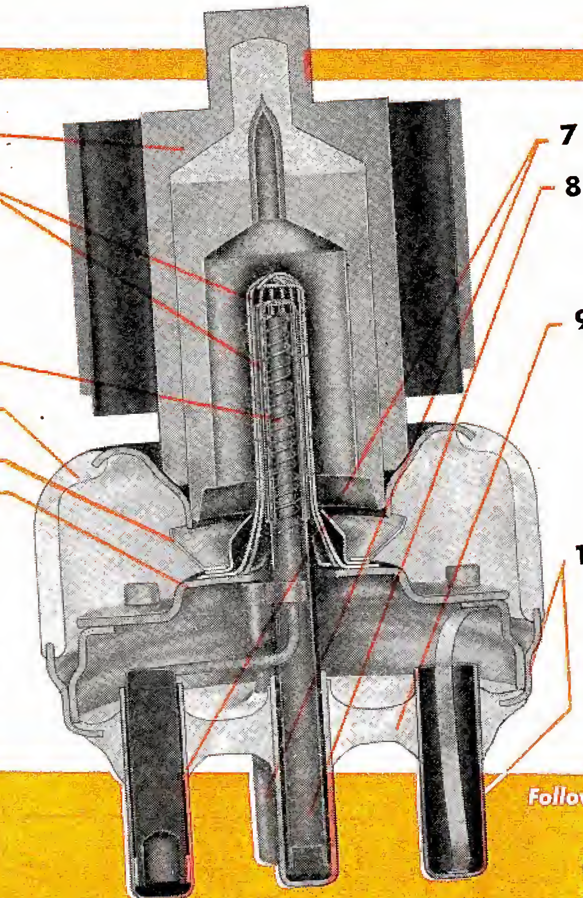
Now, with the new 4X500A, the advantages of the Eimac-designed tetrode are brought to the 500-watt class.

The 4X500A includes the outstanding VHF performance, stability, ruggedness, and freedom from undesirable primary and secondary grid emission that have made the Eimac 4-125A and 4-250A the obvious choice of transmitter engineers for important sockets in both low-frequency and VHF applications.



Here is a transmitter-man's tube intended to make life more simple for the transmitter engineer. The 4X500A is designed for functional application; note the nearly perfect shielding between grid and plate circuits made possible by the low-inductance screen mounting disc which terminates in a contact ring on the envelope. The large low-inductance tubular control-grid lead within the envelope terminates at the center of the base. This design makes it easy to build coaxial tank circuits around the 4X500A. These are only two of its many features. Among others are the rugged 500-watt air-cooled anode, Eimac-processed grids, and silver-plated terminals pointed out below.

It isn't necessary to design your transmitter around promises. Eimac 4X500A tetrodes are available NOW. They'll deliver as much as 1750 watts useful output at 110 Mc. with but 25 watts driving power (two tubes). They'll deliver 3500 watts at the same frequency with 50 watts driving power (four tubes, push-pull-parallel). Complete operating information and ratings are in the technical data sheet for the 4X500A—now available on request.



1 External Anode, 500 watts dissipation, forced air cooled.

2 Control and screen grids precisely aligned—assures maximum plate efficiency and low control and screen grid currents. (Primary and secondary grid emission is positively controlled by exclusive Eimac grid processing.)

3 Double spiral filament—rugged, stable emission.

4 Hard glass envelope—ample r-f insulation.

5 Electron bombardment shield.

6 Rigid, low-inductance screen grid mount assures improved VHF operation and permanent alignment.

7 Filament terminals—heavy duty, large contact areas.

8 Control grid terminal—low inductance, logically placed for maximum isolation between input and output circuits. Centered for use in coaxial cavities.

9 Molded glass base—maintains precise alignment of all terminals for ease and simplicity of insertion in sockets. Makes possible compact design, and low inductance lead engineering. (All base terminals plus concentric screen grid terminals are silver plated for minimum r-f resistance.)

10 Concentric ring and pin type screen grid terminals for VHF and cavity circuits or pin sockets.

CROSS SECTION
EIMAC 4X500A
POWER TETRODE

ELECTRICAL CHARACTERISTICS

4X500A POWER TETRODE

Filament: Thoriated Tungsten
- Voltage . . 5.0 volts
- Current . . 13.5 amperes

Direct Interelectrode Capacitances (Average)
- Grid-Plate . 0.05 μμfd
- Input . . . . 12.8 μμfd
- Output . . . 5.7 μμfd

Maximum D-C Plate Voltage . 4000 volts

Maximum D-C Plate Current . 350 ma.

Maximum Plate Dissipation . . 500 watts

Follow the leaders to Eimac TUBES

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WTOL-BBC

(*Continued from page 7*)

since in previous tests we had found it to have good acoustics. Table and traveling microphones were set up for the broadcast.

Mixer-Speaker Amplifiers

Mixer amplifier and speaker amplifiers were located in front of the stage so that the control operator could have a clear view of the participants and also judge the gain of the loudspeakers. The bridging amplifier and lines terminated in the control room of WTOL. Connection between WTOL and the pick-up point at the auditorium was via telephone lines. We also used a cue line so that the operator at both locations could simulate operations. This cue line was also linked to the local A. T. and T. office and New York.

The volume of the auditorium was found to be about the same as many normal size theatres.

The loops between New York and Toledo were of the class *B* type, equalized for a frequency response of 200 to 3,000 cycles. These loops terminated in the standard W.E. 111-C coils.

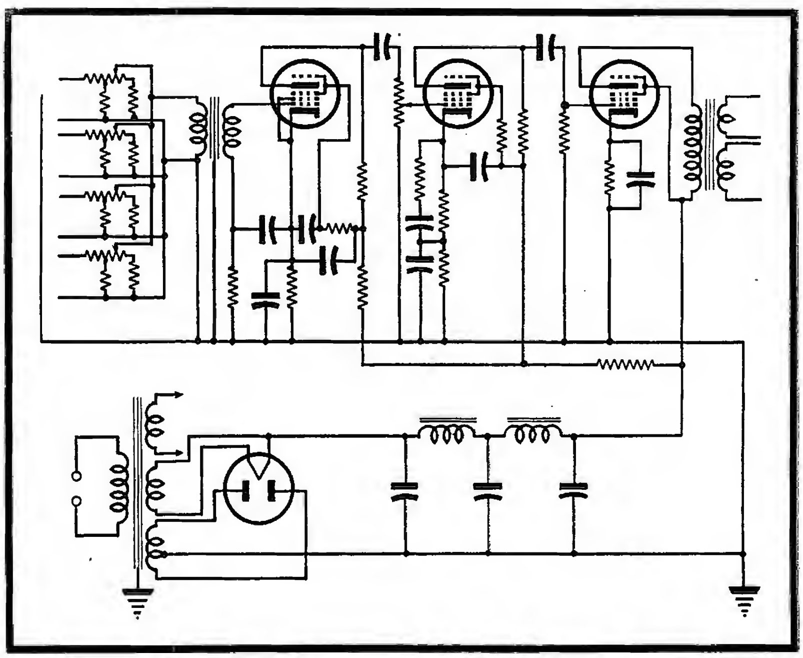
The loudspeakers used were 16" type[1] with small portable cabinets. Dynamic microphones[2] were used for fixed and portable pickup.

The loudspeaker amplifiers were composite with a 6J5 driver and a 6N7

(*Continued on page 34*)

[1] Utah.
[2] W.E. 618A (for fixed pickup) and 633A (for portable pickup).

Figure 3
Mixer and power supply.



BOOK TALK . . .

ELECTRICAL TRANSMISSION IN STEADY STATE

By *Paul J. Selgin*, Research Engineer, Farnsworth Television and Radio Corp., Formerly Instructor, Polytechnic Institute of Brooklyn. . . 427 pp. . . . New York: McGraw-Hill Book Co., Inc. . . . $5.00

The accelerated development activities initiated during wartime prompted the adoption of wide-scale practical-application procedures. Theoretical-study time was, of necessity, reduced to a minimum. To restore the balance and provide a comprehensive theoretical background Paul Selgin has prepared an extensive text, based on lecture notes presented during his war-training program courses.

Mr. Selgin introduces his project by reviewing a number of fundamental circuit, field, and network principles. Thus, he defines the steady state condition in terms of energy transmission in successive time intervals, before continuing with a discussion of the parameters which describe network performance. A considerable section of the text explores the characteristics of various networks in detail and analyzes the problems involved in coupling a generator to its load for the best power transfer through matched lines.

Mr. Selgin also presents a review of field theory and Maxwell's equations, essential to the investigation of the very high frequencies where lumped circuit concepts cease to apply. This second viewpoint is first applied to lumped systems and then to systems of two parallel conductors having distributed properties. Mr. Selgin continues with a study of coupled circuits and three-conductor systems and concludes with a series of applications of three-conductor theory to vacuum tubes.

While Mr. Selgin's book is not for light reading, he rarely demands more than a knowledge of the elementary calculus common to all physics and engineering graduates. Mr. Selgin's clear expository style, his excellent analytical approach, and the large number of illustrative charts and diagrams should make this book a valued tool for engineer and student.

WTOL-BBC

(*Continued from page 32*)

output. The input transformer had a 600-ohm impedance input to grid. Output transformer went to pushpull plates to an 8-ohm speaker. Other component values were . . . fader, 500,000 ohms; cathode resistor, 1,000 ohms; plate-dropping resistor for the driver, 5,000 ohms; cathode capacitor, 10 mfd at 50 volts.

Mixer Design

The mixer unit[3] used two 6J7s and one 6F6. Component values were: cathode bypass capacitors, 50 mfd, 25 volts maximum; .01-mfd coupling capacitors between first and second stage and .03-mfd capacitors between last two stages; plate load resistors, 250,000 ohms; grid resistors, 500,000 ohms.

Bridging Amplifier

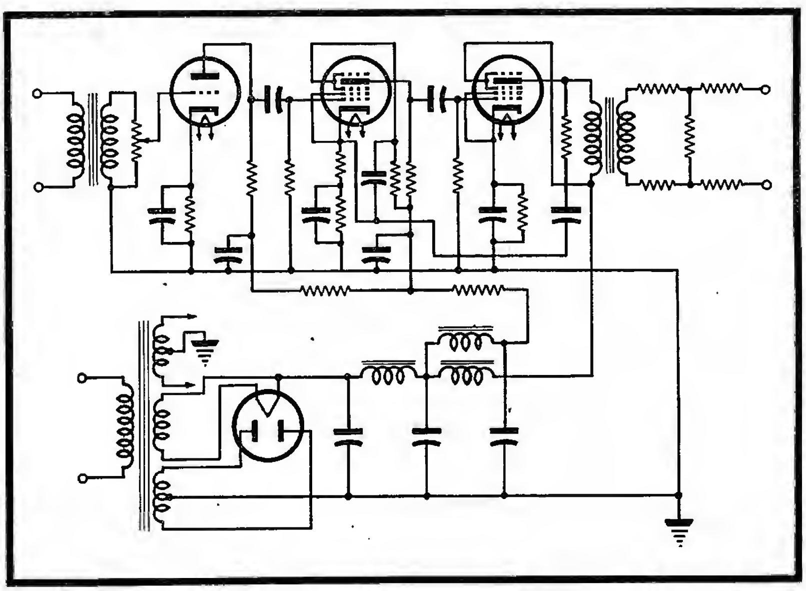
The bridging amplifier[4] used a 262B, 310B, 336A and 274A rectifier. The input and output was 600 ohms. All stages were resistance coupled, with ¼-megohm plate resistors and ½-megohm grid resistors. The cathode bypass capacitors were 50 mfd at 25 volts for first and last tubes, and 100 mfd at 12 volts for the center tube.

A front-panel push-button system connecting a section of the cathode resistor across a meter provided cathode-current readings. This provision is not shown on the diagram, Fig. 4.

The broadcast proved so successful, that additional programs are now being arranged for transmission to and from other European nations.

3, 4W. E.

Figure 4
Bridge amplifier and power supply.



TELEVISION ANTENNAS

(*Continued from page* 9)

along the line in terms of phase angle, terminating impedance and characteristic impedance.

Returning to the practical aspects of the problem it is obvious that at frequencies in the order of 50-1,000 mc measurements of absolute voltage and current are difficult if not impossible. However, if the voltage or current can be related to the ratios of maximum and minimum values at the positions of occurrence then we may solve for the complex nature of the termination.

The voltage (or current) existing along a transmission line is the vector sum of the incident wave, E_i, and the reflected wave, E_R. Figure 3 shows the revolving vectors, E_i and E_R, and the position of minimum and maximum occurrence.

$$S_R = \frac{|E_i|+|E_R|}{|E_i|-|E_R|} = \frac{E_{max}}{E_{min}} = \rho \qquad (21)$$

Where: $S_R = \rho$ = standing wave ratio
E_i = incident wave
E_R = reflected wave
E_{max} = maximum voltage indication on line
E_{min} = minimum voltage indication on line

At the occurrence of V_{min}, I is a maximum, or

$$\frac{V_{min}}{I_{max}} = Z_{min} \qquad (22)$$

Where V_{max} occurs, I is a minimum, or

$$\frac{V_{max}}{I_{min}} = Z_{max} \qquad (22a)$$

Since, at these positions the voltage and current are in phase, the impedance at these points will be resistive. It can also be shown by simultaneous solution of equations (*17*) and (*18*) that the ratio of V_{max} to I_{max} is equal to the characteristic impedance of the line, Z_o, or

$$\frac{V_{max}}{I_{max}} = \frac{V_{min}}{I_{min}} = Z_o \qquad (23)$$

Solving equations (*21, 22* and *23*) we find that at a V_{min} point, the impedance is

$$Z_{min} = \frac{Z_o}{\rho} \qquad (24)$$

At a V_{max} position, the impedance is

$$Z_{max} = \rho Z_o \qquad (25)$$

Where βd_{min} is the distance from the load to the nearest voltage mini-

(*Continued on page* 36)

FREQUENCY METER

(*Continued from page 29*)

quency-meter detector is kept low. Overloading of the detector tends to limit all signals to the same amplitude level, thus preventing comparison of signal amplitudes.

In Figure 3 appears the idealized response of a frequency meter tuning 1.0 to 1.2 mc when a 100-kc signal is being measured. It should be noted that relative amplitudes are shown since many factors determine the absolute amplitude. This figure does show, however, that the location and relative amplitude of external signals can be determined, leaving no doubt as to the fundamental frequency of the unknown signal, or to the origin of additional responses. This leads to a rather convenient method of preliminary frequency measurement.

If the unknown frequency lies below the fundamental, we may record the frequency of each successive signal heard, and its relative amplitude. The frequency interval between the two loudest signals is the fundamental of the unknown. As an example, let us suppose a loud signal is heard at 1.26, 1.575, and 1.89 mc. As previously explained, the frequency is 315 kc. The precision of this method can be improved by taking the frequency differ-

(*Continued on page 37*)

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TELEVISION ANTENNAS

(*Continued from page 35*)

mum, Z in equation (*20*) may be set equal to Z_o/ρ as follows:

$$Z = \frac{Z_o}{\rho} = Z_o \frac{Z_r + jZ_o \operatorname{Tan} \beta d_{min}}{Z_o + jZ_r \operatorname{Tan} \beta d_{min}} \qquad (20a)$$

or solving for Z_r,

$$Z_r = Z_o \frac{1 - j\rho \operatorname{Tan} \beta d_{min}}{\rho - j \operatorname{Tan} \beta d_{min}} \qquad (26)$$

Similar substitution when V_{max} is used as a reference point results in

$$Z_r = Z_o \frac{\rho - j \operatorname{Tan} \beta d_{max}}{1 - j\rho \operatorname{Tan} \beta d_{max}} \qquad (27)$$

Thus if three parameters in equation (*27*) are known, the fourth may be determined:

(*1*) Z_o is the characteristic impedance of the measurement line. Methods for determining this factor will be considered.

(*2*) ρ is the ratio of V_{max} to V_{min} and may be measured with suitable instruments.

(*3*) βd is the angular phase shift along the line and it may also be measured in terms of fractional wave-lengths.

(*4*) Z_r is the terminating impedance.

[To be Continued]

ence over N intervals and dividing by N.

Signals above the frequency meter fundamental may be identified in the same manner except that in this case the frequency interval between the loudest signals multiplied by the appropriate harmonic number is the frequency being measured. Suppose the loudest signals are heard at 1.91†, 1.70, 1.53, 1.39, 1.27, 1.17 and 1.09 mc. The unknown must be a multiple of the frequency interval between successive points, i.e., .17 mc. Arithmetical trial will prove that the unknown signal is 15.3 mc.:

Fundamental of frequency meter	1.91 mc
Eighth harmonic of 1.91†	= 15.3 mc
Fundamental of frequency meter	1.70 mc
Ninth harmonic of 1.70	= 15.3 mc
Fundamental of frequency meter	1.53 mc
Tenth harmonic of 1.53	= 15.3 mc

A trial similar to the foregoing will prove that the only frequency that will give the above results is 15.3 mc.

Measurements on a heterodyne frequency meter can be simplified by following the summarized procedure:

(*1*) Determine the approximate frequency of the unknown signal using a wavemeter, or by inspection of the oscillator circuit.

(*2*) Tabulate expected responses in terms of frequency and amplitude before setting up the apparatus.

(*3*) Make a closer determination of frequency than in (*1*) by measuring the frequency interval between the most prominent signals of equal amplitude.

(*4*) Make final precise measurement as close as possible to any convenient crystal check point. Make use of the lowest possible harmonics by utilizing the low end of the frequency range for signals below the frequency meter fundamental. Use the high end of the frequency range for signals above the frequency-meter fundamental.

•

PULSE DETECTOR

Don Lewes Hings, vice-president of Electronic Laboratories in Vancouver, B. C., Canada, with his recently developed pulse-detector system that can be used to eliminate noise.

Principles used are applicable to the second detector circuit. Detector circuit is limited by a low-impedance gating circuit, which dissipates energy during short-circuiting interval. As a result, the detector load circuit receives the lower amplitude caused from decaying waves at low-gating level and no wave form exists on the detector load circuit during c-w interval.

The wave form from the decaying waves which is developed from general noise or even from conversion noise in the receiver, is then amplified, limited and rectified and the d-c component, which is relatively constant unless interrupted by a continuous wave at the detector, is used as bias to control a balanced amplifier that is being excited by a tone generator.

NEWS BRIEFS

1947 IRE NATIONAL CONVENTION EXHIBITS TO GRAND CENTRAL PALACE

The Annual Radio Engineering Show, a part of the 1947 National Convention of The Institute of Radio Engineers, will be held in Grand Central Palace, New York City, March 3 to 6, 1947, instead of at the 34th Street Armory as previously announced.

The move to Grand Central Palace does not change the character of the convention and show. No home model radios will be shown. All displays will be of an engineering nature. There will be a registration fee to non-members.

* * *

FCC CAB-TRUCK SERVICE PLANS

The FCC recently reiterated its recognition of the need for a taxicab service and gave assurance that it will make every effort to establish this service on a permanent basis within a year. The FCC indicated that at least two channels will be required on a permanent basis. Whether additional channels can be assigned will depend upon other demands for urban mobile service. It is expected that a general hearing on the urban mobile service will be held to consider frequency and regulatory problems. Meanwhile, qualified applicants are receiving class 2 experimental licenses for taxicab operation on 152.27 and 157.53 mc.

FCC also advised the trucking industry recently that it cannot give assurance for channels until a program of experimentation has been underway or at least a plan has been worked out for a nation-wide coordinated use of the frequencies tentatively assigned for trucks. The temporary frequency assignment plan made 152.15 and 157.41 mc available on a non-common carrier experimental basis for department stores, delivery services, etc. There will naturally be some overlapping of the urban and highway services, but whether it will be necessary for trucks, in some instances, to hold licenses in both services is a detail which can be worked out by experiences, the FCC said. Further applications for experimental authorizations for truck radio systems are invited

"The more active the role trucking interests play in experimenting with and planning for radio," commented the Commission, "the closer we will be to the establishment of a permanent service."

* * *

HOPKINS NOW RCA COMMUNICATIONS AND ELECTRONIC EQUIPMENT S-M

A. R. Hopkins has been appointed manager of communications and electronic equipment sales of the RCA engineering products department. Mr. Hopkins was formerly regional manager of the department for the Chicago area.

* * *

JAQUES NOW PRESIDENT OF S. H. COUCH COMPANY, INC.

B. F. Jaques was recently elected president and board member of S. H. Couch Company, Inc., N. Quincy, Mass. He succeeds Samuel H. Couch, founder and for many years president, who becomes chairman of the board. J. Eric Atkinson remains as vice president in charge of sales and Donald F. Cameron continues as treasurer.

* * *

QUARLES BECOMES CHAIRMAN OF N. C.-VA. IRE SECTION

L. R. Quarles, professor of electrical engineering, University of Virginia, has been named

chairman of the North Carolina-Virginia section, Institute of Radio Engineers. C. G. Brenecke, professor of electrical engineering, North Carolina State College, was named vice chairman; John T. Orth, chief engineer, Tri-City station, secretary.

* * *

CARBONNEAU EXPANDS

Carbonneau Industries, Grand Rapids, Michigan, recently formed by Gordon Carbonneau, will soon begin full-scale production on all styles and sizes of loudspeakers in both the jobber and equipment lines.

Mr. Carbonneau was formerly production engineer for the Utah Radio Products Company, Chicago.

G. S. Carbonneau

* * *

FRENCH JOINS SAMS' PHOTOFACTS

B. V. K. French has been named director of field relations of Howard W. Sams and Co., Indianapolis, Ind.

During the early part of the war, Mr. French served on the Joint Army Navy Standardization Board. Late in 1944 he became supervisor of the Mallory Research Laboratory established in New York City for the further development of the type R-M mercury dry battery.

* * *

ABC APPLIES FOR N. Y. AUTO PHONE FACILITIES; CHICAGO UNIT ALREADY IN SERVICE

The American Broadcasting Company has filed an application with the New York Telephone Company for the new vehicular telephone service.

ABC Chicago news reporters are using a station wagon equipped with one of the new h-f mobile phone units.

* * *

RESISTORS, INC., BULLETIN

A bulletin, No. 87, describing fixed and adjustable resistors, ferrule resistors, heating elements, special windings and accessories, has been published by Resistors, Incorporated, 2241 South Indiana Avenue, Chicago 16, Illinois.

* * *

HEMBROOK ELECTED MUZAK V-P

Emil F. Hembrooke, director of equipment and engineering for Muzak Corporation since 1945, and previously chief engineer from 1941 to 1943, has been elected a vice president.

* * *

ROMNES NOW A. T. & T. RADIO ENGINEER

H. I. Romnes, who has been in engineering and research work in the Bell System for the past eighteen years, has become radio engineer of the American Telephone and Telegraph Company.

Mr. Romnes will head the radio section of the engineering division. He succeeds Francis M. Ryan, who previously had been named radio coordinator.

* * *

1947 BROADCAST ENGINEERING CONFERENCE CANCELLED

The 1947 Broadcast Engineering Conference will not be held according to an announcement by the departments of electrical engineering of the University of Illinois and Ohio State University, co-sponsors.

The cancellation has been caused by crowded conditions and lack of sufficient personnel at both universities. It is expected that the event

(*Continued on page* 40)

NEWS BRIEFS

(*Continued from page* 39)

will be resumed in 1948. The 1947 conference was scheduled to be held at the University of Illinois.

* * *

B. & O. INSTALLS V-H-F SERVICE ON TUGBOATS

The Baltimore and Ohio Railroad recently inaugurated a v-h-f f-m radio-telephone service to assist in the operation of its tugboats in Baltimore's harbor.

The two-way equipment, built by the Bendix Radio, will enable tug captains to remain in constant contact with their headquarters ashore, thus eliminating waste deadhead movement back to base to pick up new instructions after each assignment is completed.

* * *

INDUCTIVE EQUIPMENT EXPANDS

The Inductive Equipment Corporation has moved into a new building at Gettysburg, Pennsylvania.

Products being manufactured at the plant include magnet wire, transformers, rectifiers and various types of high-frequency equipment.

* * *

16 NEWSPAPERS TO INSTALL FTR F-M TRANSMITTERS

Sixteen newspapers in eleven states have ordered FTR f-m broadcasting equipment. Several of the newspapers are already on the air, with the remainder scheduled to begin operation soon.

The sixteen publishers who have installed or contracted for transmitters, antennas and associated equipment are:

New York Post, New York, N. Y.; Newark Evening News, Newark, N. J.; Buffalo Evening News, Buffalo, N. Y.; Milwaukee Journal Co., Milwaukee, Wis.; South Bend Tribune, South Bend, Ind.; Joplin Globe & News Herald, Joplin, Mo.; Bradford Publications, Inc., Bradford, Pa.; Niagara Falls Gazette, Niagara Falls, N. Y.; Omaha World Publishing Co., Omaha, Neb.; Paducah Sun Democrat, Paducah, Ky.; Reading Eagle & Times, Reading, Pa.; Watertown Daily Times, Watertown, N. Y.; Kankakee Daily Journal Co., Kankakee, Ill.; Truth Publishing Co., Elkhart, Ind., and the Daily Telegraph Printing Co., Bluefield, W. Va.

* * *

CAREY BECOMES MECK MANUFACTURING DIRECTOR

Amos H. Carey has been appointed director of manufacturing for the John Meck Industries, Plymouth, Ind. Mr. Carey was formerly in charge of manufacturing for RCA in Camden, N. J.

* * *

KIMBALL TALKS BEFORE CEDAR RAPIDS IRE SECTION

C. N. Kimball, formerly with Aireon company, discussed design and research for railway radio at a recent meeting of the Cedar Rapids chapter of the Institute of Radio Engineers.

Dr. Kimball is now with the Patterson Development company.

* * *

COTTER APPOINTED SCOTT RADIO CHIEF ENGINEER

William F. Cotter has been appointed chief engineer for the Scott Radio Laboratories, Inc., of Chicago. Cotter was formerly with Stromberg-Carlson as chief radio engineer and later as radio consulting engineer.

* * *

SACK AND ADELMAN HEAD NEW TRANSMITTER COMPANY

Samuel L. Sack, formerly vice president and chief engineer of Transmitter Equipment Mfg. Co., Inc., is now president and chief engineer of Supreme Transmitter Corporation, 280 Ninth Avenue, N. Y. 1, N. Y. Leon L. Adelman is vice-president and sales manager.

Charles Sheer has been named research director and consultant. Mr. Sheer is chief in-

structor at RCA Institute. **Ermano Borroni** is secretary and chief mechanical engineer and designer. He was formerly with Federal Radio as mechanical engineer.

* * *

DR. BAKER RECEIVES WAR DEPARTMENT AWARD

Dr. W. R. G. Baker, G.E. vice president in charge of the electronics department, recently received the Certificate of Appreciation from Brigadier General Calvert H. Arnold, chief of Procurement and Distribution, Office of the Chief Signal Officer for "patriotic services in a position of trust and responsibility . . . for outstanding contribution to the war effort by the development, design and production of complex Signal Corps radio and radar equipment."

* * *

BACHMANN NOW IN CHARGE OF COLLINS SPECIAL PRODUCTS SALES

A. E. Bachmann has been transferred from the engineering division of the Collins Radio Company to the sales department and placed in charge of special products.

* * *

WESTINGHOUSE TUBE DATA BOOK

A data book, 86-200, listing tubes according to family or class—phototubes, pliotrons, thyratrons, ignitrons, kenatrons and planotrons—and providing essential technical data on each tube, has been published by the Westinghouse Electric Corporation. P.O. Box 868, Pittsburgh, Pennsylvania. A separate index is arranged numerically by type number, and tells the class to which each tube belongs, its warranty class, and list price. An interchangeability chart shows the equivalent for competitive type numbers.

* * *

G.E. TO SUPPLY F-M COMMUNICATIONS FOR N. Y. STATE POLICE SYSTEM

G. E. two-way f-m communications equipment will be used in the new state-wide police radio system to be leased by the New York division of State Police from the New York Telephone Company, and expected to be in operation next summer.

Over fifty 250-watt f-m transmitters, more than 350 f-m mobile units for two-way operation, and other associated equipment such as station pick-up receivers, remote control units, and portable trunk-type equipments, will be included in the network.

* * *

I R C BULLETIN

A 4-page bulletin describing type FRW flat wire wound resistors has been released by International Resistance Company, 401 N. Broad Street, Philadelphia 8, Pennsylvania.

Bulletin contains a compilation of structural data, specifications, and performance characteristics.

* * *

PYRAMID CONDENSER EXPANDS

Pyramid Electric Company has acquired an additional single-story plant at Paterson, N. J. General offices remain at Plant No. 1, 415-421 Tonnele Avenue, Jersey City 6, N. J.

* * *

FRANK FOLSOM RECEIVES WAR DEPARTMENT CITATION

The War Department recently awarded its Certificate of Appreciation to Frank M. Folsom, executive vice president of RCA in charge of the RCA Victor Division, for outstanding contributions to the U. S. Army Signal Corps program during the war.

* * *

GROVER NOW S-M OF G.E. MARINE ELECTRONIC EQUIPMENT

Thomas Grover has been appointed sales manager in charge of marine electronic equipment in the transmitter division of G. E. His headquarters will continue at the Thompson road plant at Syracuse, N. Y.

* * *

FAIRCHILD SOUND EQUIPMENT DATA

A loose-leaf catalog describing sound recording and playback equipment has been released by the Fairchild Camera and Instrument Corporation, 88-06 Van Wyck Blvd., Jamaica 1, N. Y.

Described are studio and portable recorders, transcription turntables, magnetic cutterheads, lateral dynamic pickups, portable playbacks, etc.

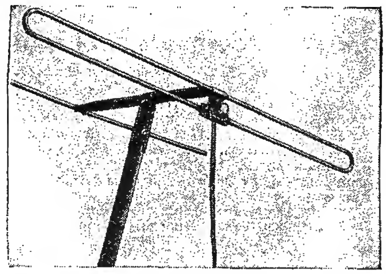
THE INDUSTRY OFFERS . . .

TACO DIPOLES

F-M and television dipoles have been announced by Technical Appliance Corporation, 41-06 De Long St., Flushing, New York.

Dipoles feature ribbon transmission line comprising two stranded conductors insulated by a band of polystyrene that is said to result in a low loss per 100′ of .02 db at 10 mc, 1.25 db at 50 mc, and 2.1 db at 100 mc, with a 300-ohm surge impedance.

Enamel-finished steel tubing is used for supporting members. Dipoles are of aluminum tubing.



* * *

BRUSH CRYSTAL MICROPHONE

A desk-type microphone, BA-106 Acousticel, that is said to provide essentially flat response from 40 to 6,000 cps, and have an output level 50 db below 1 volt dyne/cm² open circuit, has been announced by the Brush Development Company, 3405 Perkins Avenue, Cleveland 14, Ohio. Supplied complete with 8′ cable, plug and removable base, which converts desk-type microphone to hand mike for home-recording use.

* * *

BOGEN BOOSTER AMPLIFIER

Two 50 and 125-watt booster amplifiers, GO50 and GO125, have been announced by the David Bogen Co., Inc., 663 Broadway, New York 12, New York.

Two 807 tubes are used in pushpull with multi-stage inverse feedback. Response is said to be flat within 1 db from 20 to 20,000 cps. Input impedance is 500,000 ohms; with provision for balanced line zero level input for use on telephone lines etc.

Other features include oil filled input filter, preset volume control, standby relay provision and tube regulated screen supply.

* * *

G. R. U-H-F VOLTMETER

A crystal galvanometer, type 1802-A, has been announced by the General Radio Company, 275 Massachusetts Avenue, Cambridge 39, Massachusetts. Similar in principle of operation to the peak-reading type of vacuum-tube voltmeter, consisting of a rectifier and a d-c amplifier, but

uses a standard type of crystal rectifier in the probe, in place of the conventional thermionic diode.

Range .1 to 1 volt. Decade multipliers to fit the probe are supplied for multiplying factors of 10 and 100. The accuracy of indication is ±5%, subject to frequency correction, curves for which are furnished. The frequency range for direct voltage measurements is from 10 to 1000 mc, but voltage-ratio measurements can be made at frequencies well above 1000 mc, while as a simple voltage indicator, the instrument will operate up to about 3000 mc.

A coaxial adaptor and a 50-ohm disc-type terminating resistor are supplied in addition to the multipliers. Cathode and plate power for the d-c amplifier is obtained from self-contained batteries.

Input capacitance depends upon the crystal; input conductance upon frequency, voltage-level, and crystal. Representative values are 5 mmfd. and 100 micromhos.

Over-all dimensions are 7" x 7" x 10½".

* * *

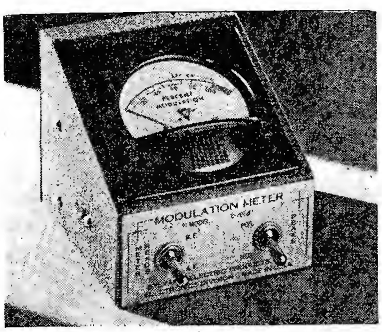
SYLVANIA MODULATION METER

A modulation meter, type X-7018, using a germanium crystal diode IN34, has been announced by Sylvania Electric Products, Inc., 500 Fifth Avenue, New York 18, N. Y. Instrument is designed primarily for use in the amateur phone bands falling between 3.5 and 54 megacycles, but is also useful for other services, such as forestry, emergency, police, and marine, which operate with a-m transmitters. It is not intended for broadcast service.

Modulation percentage is indicated on a direct-reading hermetically-sealed meter which is flush-mounted on a panel approximately four inches square.

Meter permits determination of the modulation percentage of either a sine-wave modulated or a voice-modulated carrier, as well as giving an indication of carrier shift.

Measures 4" wide, 4" high, and 4¼" deep. Supplied with a 75 ohm twin-lead transmission line for use with an external link circuit.



* * *

G. E. VARIABLE-INDUCTANCE TUNING SYSTEM

A new method of variable inductance tuning, for the 88 to 108-mc f-m band has been developed by engineers of the receiver division, electronics department, G.E.

The tuner consists of two identical silver-plated brass frames which, when connected at their open ends, form a two-turn inductance. The inductance of the two turns is varied by

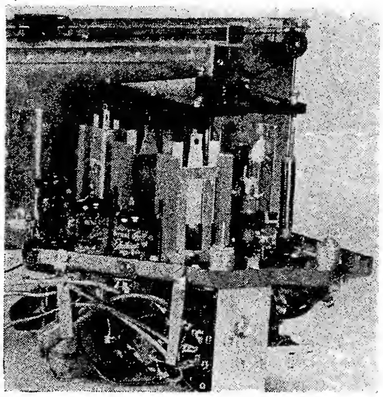
(*Continued on page* 44)

insertion of a silver-plated brass blade between the turns. The effect of the blade is to reduce the inductance of each turn and also the mutual inductance between them. The tuning curve is adjusted by cutting slots in the blade which provide an easy and permanent means of tracking the oscillator and r-f circuits with each other.

Because of its physical resemblance, this type of slide tuner has acquired the nick-name "guillotine tuner."

Additional ranges are tuned by adding shunt capacity and by adding fixed series inductance to the guillotine circuit.

The tuner assembly in completed form is enclosed in a metal box for shielding and for mechanical protection and dust proofing.



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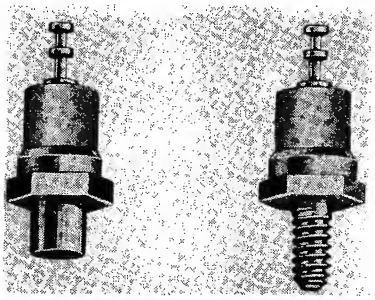
CAMBRIDGE THERMIONIC INSULATED TERMINAL LUGS

Insulated midget terminal lugs for use where high electrical stresses at r-f are encountered over a broad humidity range, have been announced by Cambridge Thermionic Corporation, 445 Concord Avenue, Dept. 9, Cambridge 28, Massachusetts.

Lugs are furnished in both the rivet and stud

THE INDUSTRY OFFERS . . .

(*Continued from page* 43)



type. Available with either CTC single or double midget lug, and have a voltage breakdown of approximately 6000 volts a-c. The rivet type mounting allows for peening the mounting shank through the panel or chassis. The stud type is fitted with a No. 6-32 thread for mounting direct into a tapped hole, using wrench on the hex top of the stud, or can be fastened to thin members with an appropriate nut.

The primary uses of lugs cover such applications as tie-points where the potential is exceedingly high and tie-points for r-f leads where losses must be kept at a minimum.

Studs are of cadmium-plated brass, and the insulotors, of Army- and Navy-approved phenolic.

* * *

KELLOGG SWITCHBOARD MIDGET CONDENSER MICROPHONE

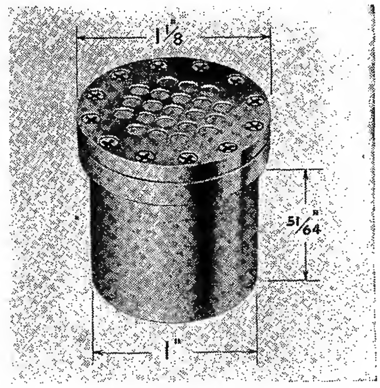
A midget condenser microphone for measurement of sound pressures has been announced by Kellogg Switchboard and Supply Company, 6650 S. Cicero Ave., Chicago.

When used with a suitable preamplifier microphone response is said to be —59 db referred to one volt/dyne/cm². Response is said to be flat to within 1 db from 100 to 7,000 cycles per second, and within 3 db from 60 to 10,000 cycles per second.

Kellogg sound engineers have used the microphone to measure acoustic intensities of 1200 to 1400 dynes per square centimeter in various couplers. Microphone uses a diaphragm stretched from .0005 dural sheeting and has an electrostatic capacity of approximately 35 mmfd.

Outside diameter of the clamping ring section is 1⅛".

Depth of the clamping ring section, including both the clamping ring and the adjacent 1⅛" diameter of the body is 9/23" total. Outside diameter of the barrel is 1" and its depth, exclusive of the clamping ring section, is about 51/64". Inside diameter of the clamping ring equals approximately the diameter of the exposed surface of the diaphragm and is ¾". Diaphragm lies approximately 3/32" below the outer surface of the clamping ring.



* * *

ANDREW FOLDED QUADRUPOLE F-M ANTENNA

An emergency standby f-m antenna, type 1200 folded quadrupole, has been announced by the Andrew Co., 363 E. 75 St., Chicago 19, Ill.

A folded-dipole turnstile, the antenna weighs less than 15 pounds. Less than a square foot

of surface is said to be exposed to wind from any direction.

Radiators are factory-tuned to the center of the purchaser's specified channel. An individually measured radiation pattern also is supplied.

Antenna can be fed by the permanent line, or by RG20/U solid dielectric cable.

A competent field installation service also is offered by the Andrew Co.

Bulletin 46 offers full details.

* * *

WARD HOUSE AND WINDOW ANTENNAS

A line of vertical type house and window radio masts has been developed by the Ward Products Corporation, 1523 East 45th St., Cleveland.

Both types of masts feature a telescopic design, and weather-proofed with cadmium plating.

House mast extends to 12' and is collapsible to 4'. Window type extends to 8' and may be collapsed to 40".

House mast has built-in lightning arrester.

* * *

G. E. CAPACITOR-RESISTOR BRIDGE

A portable capacitor-resistor bridge, type YCW-1, has been announced by the specialty division of the electronics department of G. E.

Unit will measure capacity from .000005 to 200 mfd in three ranges and resistance from 5 ohms to 20 megohms in two ranges. Using the wein-bridge principle with standards of ±1 for capacitance and ±2% for resistance, bridge balance is indicated by an electronic visual indicator tube.

Insulation resistance, leakage current and power factor are among the other electrical characteristics of capacitors that may be measured. Power factor is measured on the high capacity range by a potentiometer in series with the standard resistance which has a scale of 0% to 50%.

* * *

VAN DYKE POTENTIOMETER

A linear, wire-wound resistor of the helical type has been announced by Van Dyke Instruments, P.O. Box 696, Tarzana, Calif.

Resistance element consists of an alloy core over which is wound a single, closely spaced layer of low-temperature coefficient resistance wire. Linearity of the completed resistance is

(Continued on page 46)

maintained by electronic control during winding process.

Resistance values up to 3000 or 6000 ohms per turn, using Advance or nichrome wire, respectively. Linearity is said to be better than .5%.

All parts are machined.

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BARBER HIGH-FREQUENCY VOLTMETER

A high-frequency electronic voltmeter, model 32, equipped with a radio-frequency probe having an input capacity of ¾ mmfd has been announced by Alfred W. Barber Laboratories, 34-14 Francis Lewis Blvd., Flushing, New York.

Voltmeter measures 0.3 to 300 volts r-f in five ranges (3, 10, 30, 100 and 300 volts full scale). The frequency range is 500 kc to 500 mc. Tubes: one 6AL5 in probe, two matched 6J6 and one 6X5GT rectifier.

* * *

DU MONT CABLE TESTER

A cable tester has been announced by the Allen B. Du Mont Labs., Inc., Passaic, N. J.

Test coil used is connected by a short length of cable to the small oscillator unit located closely to the wire rope under test. A special cable in 100' lengths is provided to connect this oscillator unit with the main or oscillograph unit usually kept at a distance from the actual test. Provision is also made for adjusting the instrument sensitivity either on the remote oscillator unit or the main unit.

In addition to instantaneous reading on the oscillograph screen as the cable passes through the test coil, there is also a permanent recording means. A d-c output is provided by a circuit designed to operate an Easterline-Angus 1 mil. recording milliammeter. The meter reading increases as total core losses increase.

THE INDUSTRY OFFERS . . . —

(*Continued from page* 45)

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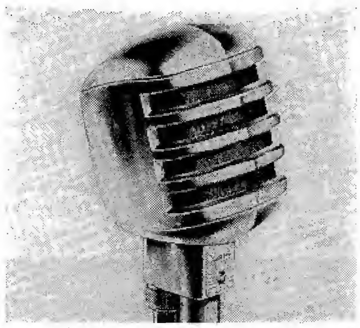
ELECTRO-VOICE DYNAMIC AND CRYSTAL MICROPHONES

Two dynamic and crystal microphones have been announced by Electro-Voice, Inc., Buchanan, Michigan.

Dynamic, type 610, employs the E-V Acoustalloy diaphragm which is said to withstand high humidity, extremes of temperature, and severe mechanical shock. Also uses Alnico V in the magnetic circuit. Output level is —53 db. Available in Hi-Z (direct-to-grid, 25,000 ohms), 50, 250 or 500 ohms impedance.

Crystal microphone, model 910, employs a high capacity moisture-sealed crystal, and duralumin diaphragm. Output level is —48 db. High impedance.

Both models have a 15° fixed tilt for effective aiming at the sound source. Frequency response is said to be substantially flat from 50-8000 cps. Polar pattern is non-directional at low frequencies, becoming directional at higher frequencies.



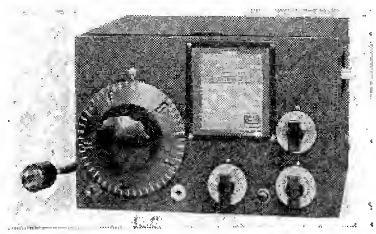
Complete information appears in catalog No. 101.

* * *

NATIONAL AIRCRAFT RECEIVER

A receiver, NC-One-Ten-A which can be used in the 118-mc aircraft band, as well as in the 1 to 10-meter field has been announced by the National Company, Malden, Mass.

Receiver uses a tuned r-f stage, a self-quenching super-regenerative detector, a transformer coupled first stage of audio, and resistance coupled power output stage. Tubes: 954 r-f; 955 detector; 6J5 first audio, and 6V6 second audio.



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ATLAS H-F TWEETER AND DIVIDING NETWORK

A h-f loudspeaker, with integral dividing network, HF-1, has been announced by the Atlas Sound Corp., 1447 39th Street, Brooklyn, N. Y.

Dividing network is designed to eliminate phase distortion in the cross-over region. A volume control is incorporated to adjust the level of tweeter to balance that of the particular woofer chosen. A transfer switch is also provided to cut out the tweeter and network for relatively narrow band a-m radio reception, reproduction from scratchy records, or other average quality signals having excessive noise or noticeable distortion.

Maximum power capacity with woofer connected, 20 watts of speech and music. Moulded

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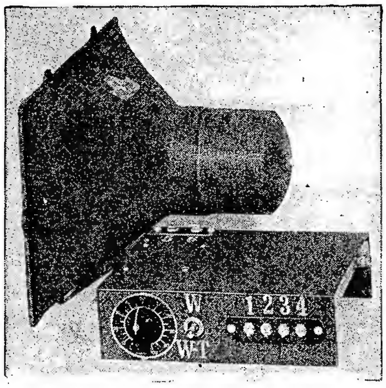
phenolic diaphragm with Alnico V permanent magnet. Frequency response, ± 6 db 50-14,000 cycles, with suitable woofer. Spatial distribution, horizontal —80°, vertical —40°.



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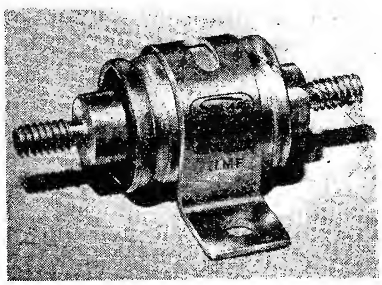
SOLAR FEED-THRU FILTER CAPACITORS

Three terminal network filter capacitors that are said to be capable of continuous use at currents up to 100 amperes with line voltages up to 250 volts a-c, have been released by Solar Manufacturing Corporation, 285 Madison Ave., N. Y. 17, N. Y.

Capacitors were originally developed for wartime applications in attenuating radio interference from motors, generators and other electric equipment. Available in values up to .75 mfd. Hermetically sealed and furnished in corrosion-resistant metal housings.



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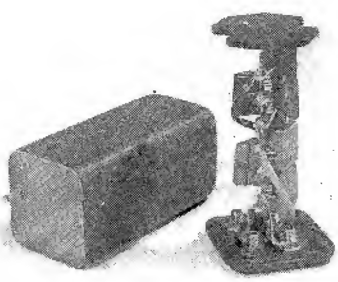
KAY-LAB WIEN-BRIDGE FILTER

A wien-bridge filter to cancel hum, both 60 and 120 cycles, when using an oscillograph or vacuum-tube voltmeter, has been announced by Kalbfell Laboratories, 1076 Morena Boulevard, San Diego 10, Calif. Consists of two wien bridges in cascade, the first one balanced for 120 cycles and the second for 60 cycles. Terminals are brought out so that these bridges may be used separately for analyzing the composition of hum voltages when trouble shooting.

Mica capacitors and low temperature coefficient resistors are used. Assembly is sealed in polystyrene.



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PHILIPS MIDGET CRYSTALS

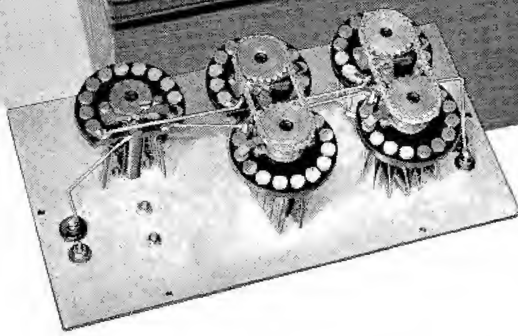
A midget quartz crystal for controlling the frequency of dielectric heating and other similar installations has been announced by North American Philips Company, Inc., 100 East 42nd Street, New York.

Less than ⅝" in diameter and 1¼" long.

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS—JANUARY, 1947

1,000 DIFFERENT VOLTAGE RATIOS!



THIS decade voltage divider will supply exact voltage ratios between 0.001 and 1.000 in steps of 0.001. It is very useful on the input of amplifiers and other high-impedance circuits for reducing the input voltage by a definitely known ratio, which can be varied in very small steps. One thousand different ratios can be obtained.

The input resistance remains constant regardless of dial settings, consequently reaction on the input voltage is eliminated.

The instrument is equivalent to a pair of our type 602 Decade-Resistance Boxes connected in series and so arranged mechanically that as resistance is taken out of one box it is added to the other to maintain the total resistance constant at 10,000 ohms.

All resistors are wound with an alloy wire of such characteristics that no difficulty from thermal emf will be encountered in direct-current measurements.

TYPE 654-A DECADE VOLTAGE DIVIDER ... $100

ABRIDGED SPECIFICATIONS

ACCURACY: each resistor is adjusted within ±0.1%; error in voltage never exceeds ±0.2%

INPUT IMPEDANCE: constant resistance of 10,000 ohms regardless of ratio setting

OUTPUT IMPEDANCE: varies from 10 to 10,000 ohms, depending upon settings

FREQUENCY CHARACTERISTIC: if external capacitance across output terminals is less than 20 micromicrofarads, frequency error is less than 0.1% below 10,000 cycles

TEMPERATURE COEFFICIENT of resistors is less than ±0.002% per deg. C at normal room temperature

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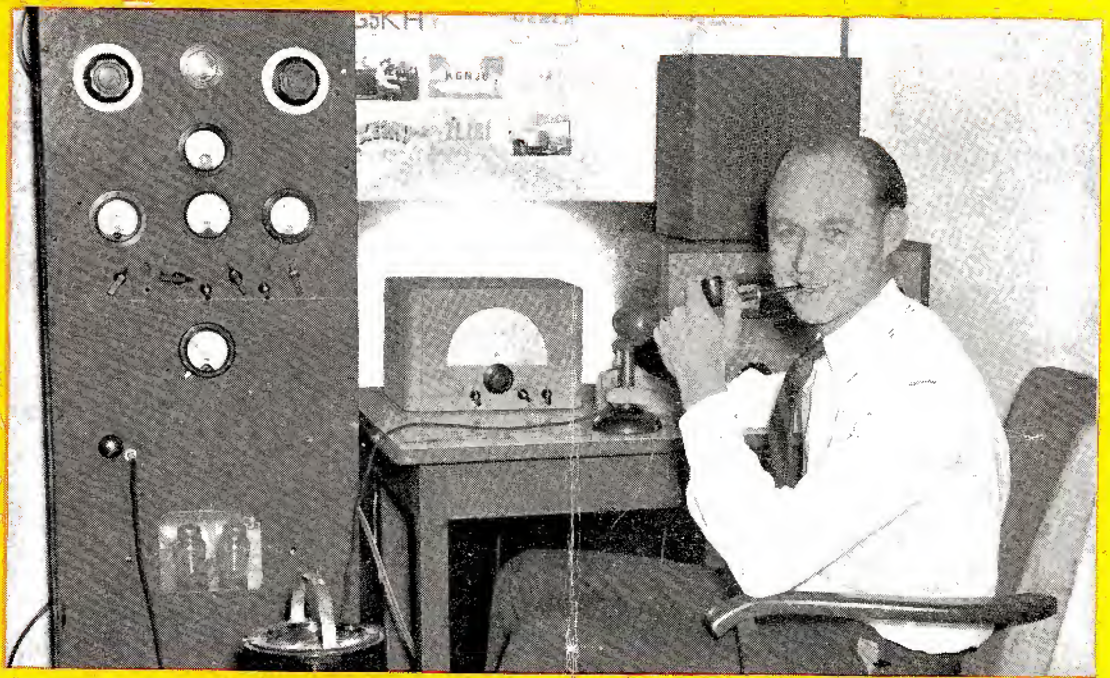
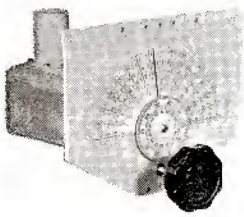


The Collins 70E-8 wins an Enthusiastic Booster!

Frank W. Oberlander, W9YPS

When W9YPS got his 70E-8 PTO (permeability tuned oscillator), we asked him to give it a workout and send us his comments. He did, and we'd like to quote him:



Frank's exciter line-up, following the 70E-8, consists of a 6AK6 isolator (untuned), 6AG7 buffer-doubler, 7C5 buffer-doubler. Here are some of the reasons why he's happy with his PTO:

1. The 70E-8 is accurate to within ½ kc on 80 meters.
2. It's calibrated directly in frequency.
3. The frequency range of 1600-2000 kc is covered in sixteen turns of the vernier dial.
4. The stability is within 1 dial division.
5. The dial covers the 80, 40, 20, 15, 11, and 10 meter bands.

Write for an illustrated bulletin with full details.

Galesburg, Illinois
October 1, 1946

Collins Radio Co.
Cedar Rapids, Ia.

Gentlemen:

I wish to express my appreciation of the new 70E-8 PTO. I have used this unit since the latter part of July on 75 meter phone, 80 meter cw, 20 meter phone and cw and 10 meter phone and cw. I cannot fully describe the feeling of assurance that this unit affords in the matter of stability and ease of frequency spotting. I am sure it has enabled me to make many contacts that otherwise I would not have made. All reports are very favorable as to stability and freedom from chirps. All contacts on cw were greeted with T9X reports.

It certainly is one of the finest pieces of equipment that I possess and I would truly feel lost if I had to be without one.

Yours very truly,
Frank W. Oberlander (W9YPS)
457 Fifer Street
Galesburg, Illinois

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